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VIRUS INFECTION OF THE MAMMALIAN FETUS[1]

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EXPERIENCE extending over a number of years with experimental inoculation of embryos of incubating hen-eggs has demonstrated a high degree of susceptibility of the developing avian cells and tissues to a number of infectious agents including viruses, bacteria, spirochaetes, fungi and protozoa. It is evident that this avian host in its embryonic stage is much more susceptible to several infections than are adult chickens and perhaps more so than the natural host of particular agents concerned.

Indicative of a greater susceptibility of chick embryos as compared with the adult hen or with a mammalian host is the wide dissemination of focal areas of infection within the body of the embryo inoculated in the chorioallantoic membrane with, for example, the viruses of vaccinia or herpes simplex, neither of which causes more than a mild local lesion in chickens, and ordinarily no conspicuous if any disseminated lesions in mammals. It is not to be inferred, however, that avian embryonic cells and tissues can be infected by any virus or other agent, for they possess toward some agents a complete refractiveness that is of the nature of natural immunity.

Experimenters who have utilized mammalian em-

[1] A lecture delivered before Section B–17 of the Symposia of the fiftieth anniversary of the University of Chicago, September 26, 1941.

bryos for the study of infection have come to the conclusion likewise that these fetal tissues are sometimes exceedingly susceptible. Such was the inference of Gallagher and Woolpert from the results of inoculation of rabbit embryos with vaccinia virus, and of guinea pig embryos with the salivary gland virus.

It is not possible at the present time to explain the high degree of susceptibility of embryos, but even from observations upon some virus lesions of adults there is indication that young and relatively undifferentiated cells sometimes appear to be more propitious media than mature cells of the same kind. If the active metabolic processes of growing cells should enhance the susceptibility of a particular environment, then the embryo obviously might offer a fertile field for virus multiplication. Another possible contributing factor is the absence or relatively ineffective use of a specific immunity mechanism in the embryo. The progress and pattern of an infectious disease in an adult are the resultants of the operation of protective mechanisms that sometimes are very rapid and efficient, sometimes slow and ineffectual.

The indicated, and even in some instances demonstrable, exceeding susceptibility of embryonic tissues to certain infectious agents leads one to a consideration of the phenomena and frequency of prenatal infections in general, and especially of those affecting the human fetus. Instances of prenatal infection are not uncommon and under some circumstances infection of the embryonic tissues is the most conspicuous and dramatic feature of the disease, particularly when it results in abortion. Such is the case, for example, with so-called virus abortion of mares, studied especially by Dimock and Edwards, in which the foal becomes extensively infected with a specific virus, whereas the mother may present little or no clinical evidence of disease. Similarly, brucellosis of cattle results frequently in abortion and the chorionic cells of the fetal placenta are heavily infected with *Br. abortus,* as was shown by Theobald Smith.

In human beings intrauterine infection of the embryo has had its most conspicuous exemplification in congenital syphilis, although virus infections, especially those of the great contagions, like smallpox, measles and chicken-pox, while well known, are rare.

An incomplete review of the literature reveals well-authenticated instances of smallpox, measles and chickenpox in newborn infants. Intrauterine mumps, scarlet fever, erysipelas, recurrent fever, malaria and infection with *E. typhi* have also been reported.

The relative infrequency of infection of the fetus from the maternal disease is indicative of a rather effective barrier between the susceptible tissues of the embryo and the virus- or germ-bearing cells and fluids of the mother. In the case of infective agents carried by the blood stream the determinative barrier in all probability is placental. Rarely if ever does an immune mother permit the passage of infection through the placenta to the fetus. Intrauterine infection is really one concerned with the spread of disease in a susceptible and infected mother to her intrauterine charge.

In the case of an immune mother bearing in her womb the susceptible tissues of her fetus another problem is introduced; namely, the problem of the transplacental transfer of specific immune bodies, which will be touched upon in the discussion.

In the event the mother is infected with a microbial parasite that lives and multiplies in the body fluids and is transported by the blood stream, the pathogenesis of intrauterine infection is probably quite different from that involved in the passage of a virus from mother to fetus. In the former instances the motility of the parasite or a breach of continuity in the placental barrier due to a focus of infection, an infarct or otherwise, might be the determining factors, but in the case of a virus brought into contact with an intact placenta the element of relative susceptibility of the cells which constitute the maternal-fetal union might be of prime importance.

It is my purpose in this lecture to present some recent experimental work that has to do with the susceptibility of the cells of human placentas and fetal membranes, and to discuss some of the observations which Dr. K. Anderson and I have made in relation to problems which I have endeavored briefly to suggest to you.

As a result of interest in devising new means of approach to studies of virus infections Drs. B. Douglas, K. Anderson and I succeeded a few years ago in grafting human skin on the chorioallantois of chick embryos. The grafts became readily established and were well-nourished throughout the remainder of the incubation period. The human cutaneous epithelium under these circumstances was proven to be susceptible to infection by the viruses of vaccinia, smallpox and herpes simplex.

By means of this technique we tested the possibility of infecting human epithelium with material from the vesicles of varicella and herpes zoster because the presumptive viruses of these two diseases have not yet been successfully inoculated in any other than the intact human host. Our experiments were not successful in this respect, and our failure led us to the use of grafts of human fetal membranes similarly implanted on the chick chorioallantois, on the assumption that they might be more susceptible than human skin.

It was our desire to test especially the susceptibility of human fetal cells to the viruses of varicella and zoster, but again we were unsuccessful in inducing these infections in the grafts. However, the grafts

themselves and their reaction to inoculation with certain other viruses were of considerable interest, especially in view of the fact that the human fetal membranes have not heretofore, so far as I know, been subjected to study by means of this technique. Before entering into a discussion of our results I should like to call your attention briefly to the procedure which we used.

TECHNIQUE

Human placentas and membranes were received directly from the obstetrical operating room in a sterile pan covered with a sterile towel. With sterile instruments an area of thin membrane was located in the neighborhood of the placenta. A sheet from 5 to 8 cms square was cut out with scissors and spread upon a previously prepared sterile block of cork. Slabs of cork about $10 \times 15 \times 3$ cms were beforehand wrapped in gauze and paper and sterilized. Just before using, the wrapping was removed and the gauze moistened with sterile saline. The gauze was then folded back, exposing the cork surface, and upon this the sheet of membrane was spread with the chorionic surface upward, if that membrane was to be used for grafting. Upon the exposed surface of the chorion lies a layer of decidua which was first stripped off with forceps. There remained a thin sheet of chorion and underlying amnion. These were easily separated with the aid of forceps. The sheet of chorion was folded upon itself with the epithelial surface enveloped until used.

The chorionic membrane was then spread out on the cork with the epithelial surface uppermost, and with a sharp scalpel it was cut into 1 cm squares, as many as needed.

Eggs incubated 9 to 11 days were prepared beforehand for opening, by cutting a square window through the eggshell and coating the surface with melted paraffin. They were then placed in the incubator with window up until ready for use.

The window was opened by cutting the shell membrane on three sides with a half spear-point needle and tearing off the dislodged shell from the fourth side. A puncture through the shell overlying the air-sac facilitates dropping of the exposed membrane. A square of human membrane to be grafted was adjusted to the flat end of a small, sterile, searing iron of polished steel, with mesodermal surface exposed. The graft was then placed on the chorioallantois, dislodged from the searing iron and smoothed into place. The window was closed in the usual way with a vaseline-paraffin ring upon which a coverglass was laid. The grafts were fixed at desired intervals by cutting out the chorioallantois to which they were attached, placing it on moist, absorbent paper, and fixing in Zenker's fluid.

The procedure was the same when amniotic grafts were desired. The membranes were placed on the cork always with the surface to be grafted uppermost. The two membranes were then separated, but that which was downward with the epithelium in contact with the cork was always discarded. Bacterial contamination of grafts from the placental membranes prepared in this way was observed only very rarely.

DESCRIPTION OF GRAFTS

The human membranal grafts became attached readily to the chick chorioallantois, and survived throughout the period of incubation, under favorable circumstances. Both chorionic and amniotic membranes are very thin and avascular and nourishment took place apparently by plasmatic circulation; for there was no vascularization. An amniotic graft appears in microscopic sections as a single layer of cuboidal or low columnar epithelial cells resting upon a hyaline basement membrane. Beneath the basement membrane is a delicate layer of collagen containing rare nucleated cells. The chorionic layer is thicker. Its epithelial surface is composed of several thicknesses of its polygonal cells that rest upon a hyaline membrane; beneath which is avascular collagenous tissue, containing few cells, but relatively more than the amnion.

Inoculation of a graft was usually performed about 24 to 48 hours after grafting. A paste of virus-containing tissue was applied directly to the presenting surface of the graft without scarification.

By means of this technique we succeeded readily in infecting grafts of human amnion with the viruses of herpes simplex, variola and vaccinia. In addition to these Dr. Anderson also succeeded in inducing in human amniotic grafts infection with the virus of mare abortion (Dimock and Edwards) which hitherto had not beyond doubt been propagated in the tissues of an alien species.

It was of interest to observe, however, that, in comparison with the amnion, human chorion was very resistant to all the viruses used, and it was only rarely that Dr. Anderson succeeded in infecting the latter with herpes simplex, variola, and vaccinia. In no instance did infection with the virus of mare abortion occur in human chorionic epithelium.

Because embryonic cells of the developing egg are not demonstrably susceptible to infection with the virus of mare abortion, successful infection of human amniotic grafts with it has served to demonstrate, not only the susceptibility of human fetal tissue to this virus, but also that a susceptible tissue grafted upon the non-susceptible chorioallantois of the chick embryo does not lose thereby its susceptibility. Likewise an insusceptible tissue when grafted upon the

chorioallantois does not become susceptible to a virus that readily infects the latter. This was shown by grafting human amnion onto the chorioallantois and inoculating it with fowl-pox. Although the infected, hyperplastic and inclusion-containing epithelium of the chick membrane impinged directly upon that of the amnion no evidence of infection of the latter was discernible.

Relative Insusceptibility of Chorionic Epithelium of the Human Fetus as Compared with Human Amnions

For the purposes of the present discussion the difficulty we experienced in securing successful infection of the chorionic epithelium, while amniotic epithelium readily and regularly became infected, is of particular interest. In several experiments in which chorion and amnion were implanted on the same chorioallantois and inoculated with the same material simultaneously and as nearly as possible by the same technique, amnion became infected but chorion remained refractive.

Several possible explanations occurred to us, among them the circumstance that the fetal membranes might have been obtained from women who had acquired an immunity to the particular viruses which we used. Although this did not seem to us a likely explanation of our failure to infect the chorion with the virus of mare abortion, our lack of knowledge of this agent excluded elimination of the perhaps remote possibility of acquired human immunity to it. But we were able to obtain experimental evidence directly opposed to an assumption that acquired antibodies in the chorion, not effectively present in the amnion, might have been the cause of the difference in their respective susceptibilities.

The human placenta is so constructed that the chorionic epithelium is in direct contact with the mother's blood. Rodents, apes and man have placentas of this so-called hemo-chorial type, but in other types of mammals the relationship of the chorion to the mother's blood is not so intimate, for it is separated from the maternal blood by various membranes and supporting tissue, in swine by five layers and in ruminants by four. Therefore in discussing the question of transplacental infection or immunity the uteroplacental structure is a most important and perhaps determining factor. I shall have occasion to refer to this difference in placental structure again.

Assuming, however, that maternal immune bodies did come in direct contact with the chorionic epithelium and remained associated with it in the membranal grafts, there is experimental evidence that they would not be effective in preventing infection of the grafts. Evidence against this was obtained from grafts of skin, especially skin from chickens rendered completely refractory to fowl-pox as a result of infection and repeated inoculations with the fowl-pox virus.

Dr. Anderson and I were able to show that such immune skin became quite susceptible to infection by the fowl-pox virus after being grafted on the chorioallantoic membrane of developing hen-eggs, and regained the refractory state when regrafted upon the immune fowl. It appeared from these results that whatever factors contributed to the immune state they became ineffective when the epithelium of the skin was removed from the immune animal and was grafted on the chorioallantois. In the case of antiviral antibodies the probability is that they became diluted and absorbed by the plasmatic circulation in the graft. Another indication of the loss of resistance of tissue to infection by a virus following grafting on the chorioallantois was the susceptibility to vaccine virus of grafts of human skin from persons who were actively immune to cutaneous vaccinia.

These experimental results indicate that if chorionic epithelium should acquire antibodies from direct contact with the mother's blood these antibodies would not be effective in preventing infection should the chorion at the time of inoculation be already grafted upon the chorioallantois of chick embryos.

Another explanation of the apparent relatively firm resistance of chorionic as contrasted with amniotic epithelium is based upon mechanical reasons, and should receive further investigation. In our experiments portions of the fetal membranes were used in which the decidua was firmly attached to the chorion and was separated by peeling. There is a certain amount of degenerated cells in the cleft between the two, and unless this is removed virus placed upon the surface might not contact the chorionic cells. In one instance in which the decidua was separated and removed as completely as we could, infection of chorionic cells with the virus of herpes simplex did occur. In other instances, however, where cuts were made through the chorion with the iris scissors to expose the underlying cells, and virus was inserted, no infection was observed. In addition to the possible obstructing effect of overlying decidual tissue it appears that the chorionic epithelial cells possess a sort of intercellular matrix which keeps them from intimate contact with each other. This too might operate to prevent the spread of viruses because these agents seem to require an intracellular environment for their multiplication.

Finally, it might be assumed that chorionic epithelium of man is naturally a resistant medium for the viruses which we have used, and for others that infect pregnant women. Recalling the intimate relation of mother's blood to chorionic epithelium of the fetus it is difficult to escape the conclusion that the latter is of a low grade of susceptibility, because in

relatively few cases does it appear that the fetus contracts from an infected mother such very contagious diseases as measles, mumps, chicken-pox and influenza. That being the case, it would seem more logical to assume the exceptions to be due to a breach of continuity in the chorion such as by focal areas of infection or by infarcts rather than that in such instances the chorionic epithelium was abnormally susceptible. The results of experimental study of the permeability of placentas to colloidal and particulate materials are also against the presumption that they would be pervious in an uninjured state to viruses and other infectious agents.

Transplacental Passage of Particulate Matter

While knowledge is yet too incomplete to permit the formulation of any general theory of permeability of the placenta or to permit decision whether the placental barrier of mammals is a filter or has secretory functions, there is much evidence to show that toxins or foreign proteins practically never pass even the hemochorial placenta, although antibodies readily do so. It seems worthy of emphasis that although foreign proteins in general do not pass through the hemochorial placenta, antibodies (agglutinins, hemolysins, antitoxins, antiviral bodies), whether of foreign origin and introduced passively into the mother, or originating in the maternal tissues as a result of active immunization, do, it appears, pass through readily. According to the estimates of Lewis and Wells and of Boyd, the blood of the human fetus is practically devoid of euglobulin, which indicates that this protein does not pass freely from mother to fetus, although it is often the fraction associated with antibody. The suggestion is obvious that there might either be a selective action of the chorion which permits the passage of a protein antibody, or that the antibody is a smaller and more diffusible molecule than would be expected were it identical with a serum globulin.

The experiments of Wislocki and of others demonstrate how actively phagocytic the cells of the chorionic epithelium of certain animals are for large molecules of colloidal dyes, and it is likely that foreign proteins and particles of other kinds are taken up similarly by these cells.

If this is true it would be difficult to escape the conclusion that human chorionic epithelium which is in immediate contact with maternal blood likewise contacts and probably incorporates particles of certain circulating viruses and other infectious agents. If these cells were as susceptible as some other fetal tissues it would seem likely that fetuses of infected mothers would rarely if ever escape intrauterine attacks of such diseases as measles, smallpox, chickenpox and yellow fever in which the respective viruses are known to be present at least in certain stages in the circulating blood. As a matter of fact, intrauterine infection with these viruses is at most of relatively rare occurrence, and is observed most frequently in smallpox.

Intrauterine Virus Infections in Human Fetuses

Of all intrauterine infections with the viruses of the common contagious diseases smallpox seems to be the most common and has been observed for many years, yet no statistical data on the relative frequency have come to my attention. Intrauterine infections with measles and chicken-pox, though rare, are authentically established. Rare reports of infection of the fetus with mumps, influenza, yellow fever, encephalitis and rabies can not be accepted with a great deal of assurance.

Virus Infections of Mammals Readily Transmissible to the Fetus Presumably by the Mother

There are other virus diseases of mammals, however, that are commonly transmitted to the fetus, and in at least one of them, abortion of mares, the only conspicuous evidence of the prevalence of the disease is the event of abortion of an infected foal.

In human beings the so-called "inclusion disease" (a very poor name) characterized by a wide-spread occurrence of foci in which cells of various organs contain large intranuclear and sometimes cytoplasmic inclusions, has been found in several cases in newborn infants and in the stillborn. The presumptive virus of this infection appears to be similar to those that cause infection of the salivary glands of other mammals, *i.e.,* guinea pigs and mice, the virus nature of which has been ascertained. In guinea pigs the infection is not contracted *in utero,* and in human beings, although a fetus may be infected, there is as yet no information relative to infection of mothers.

Experimental evidence of Markham and Hudson derived from inoculation of guinea pig fetuses with the salivary gland virus indicates a firm resistance of the chorionic epithelium of that species to infection with it. They state that "the remarkable resistance of the chorionic epithelium to infection and injury when surrounded by masses of infected fetal mesenchyme is a striking feature of the placental pathology."

In abortion of mares the mother of an infected foal usually shows little or no evidence of disease, and nothing is known about the pathogenesis of her infection, although the fetus can be infected and resulting abortion caused experimentally by inoculation of the pregnant mare.

In mice lymphocytic choriomeningitis (which sometimes affects human beings) may be a prenatal infection passing from generation to generation, often

causing little damage to adults. Pregnant females that continue to carry virus in the blood after clinical recovery transmit the virus to their embryos. The mechanism of intrauterine infection is unknown. Traub speaks of a possible "growth" through the placenta.

Bacterial Infection of Mammalian Fetal Membranes

In natural infection through the placenta the chorionic epithelium is in at least one bacterial disease the susceptible rather than the resistant membrane, and its infection determines the picture of the fetal disease that eventuates in abortion. This selective susceptibility of the chorionic epithelium was demonstrated by Theobald Smith in bovine fetal membranes infected with *Brucella abortus*. Only the chorionic membrane is involved, but it is markedly altered by the fact that practically every cell of certain areas is distended to the point of rupture with densely packed masses of the tiny bacilli. It seems probable in this disease that the bacilli enter the utero-chorionic space by way of the blood vessels in the uterine wall and then become phagocytosed by the chorionic epithelium in the cytoplasm of which they find a stimulating medium for their growth. It is quite possible that focal areas of infection of the uterine mucosa serve as distributing centers from which the bacteria gain access to the utero-chorionic space.

Some such peculiar susceptibility of the chorion or other placental cells probably permits the multiplication of the virus of mare abortion, although this has not been demonstrated.

Thus it appears that instead of acting as a barrier to infection the fetal membranes might offer especially favorable conditions for both bacteria and viruses of certain kinds. This fact emphasizes the importance of a consideration of the cells of the membranes, especially the chorionic epithelium, in relation to their relative susceptibilities with respect to specific infectious agents that may attack the pregnant mother.

The fact that the fetal membranes can be grafted on the chorioallantois and inoculated in this detached situation offers an opportunity for the study of specific resistance and susceptibility hardly possible in the intact host, especially in the human host.

Most human mothers are actively immune to the great contagious diseases, which now are largely infections of childhood; and because the fetal chorion is in immediate contact with maternal blood, it is a fortunate circumstance for fetal health that immune bodies readily pass through the placenta in protective amounts to the offspring. In those mammals whose placental structure does not permit passive immunization of the fetus, resistance of the new-born may result from an absorption through the gastro-intestinal tract of immune bodies conveyed by the colostrum and to a less extent by the milk.

Owing to the obvious importance of the placental union in determining whether or not infection of the fetus takes place, it is rather surprising to find so little knowledge concerning placental infection, and the relative specific resistance of placental and fetal membranes.

Our experimental observations concerning the inoculation of human fetal membranes grafted on the chorioallantois of chick embryos indicate that the human chorionic epithelium is naturally a resistant membrane to a number of viruses, and the relative rarity of fetal infection by the active agents of the great contagions leads one to conclude that it is resistant to others which it was not practicable for us to test.

SCIENCE AND WAR

By Dr. PETER L. KAPITSA

MEMBER OF THE ACADEMY OF SCIENCES OF THE U. S. S. R.

War demands maximum effort of the belligerents—not only of the army but of the whole organism of the country. Our industry, transport and agriculture must give their utmost; for the greater our output of agricultural produce, munitions and armaments, the swifter our advance to final victory.

War demands unusual effort by creative, scientific thinkers. For instance, factories must simultaneously increase their output and cut down the number of their workers, at the same time that they lose some of their sources of raw materials. Thus, to raise labor productivity by improving technology and the process of production acquires particular importance. Hence, the exceptional value and need of inventive work.

The need to relieve the burden of the transport system makes it essential to harness local resources to serve industry. This in turn necessitates a search for new sources of raw materials or, in the absence of such sources, a search for substitutes. In this field the principal task falls to science.

Finally, armaments too must be constantly improved. The creation of new types of weapons and

the perfection of old ones confront science with a whole series of urgent questions that must be answered.

That is why, both in our country and in the countries allied to ours, the war has faced scientific workers with many problems urgently requiring solution.

The whole Soviet people, including the scientists, understands well enough that only by straining ourselves to the utmost can we drive out the hated invaders with least damage to our country. We understand that the struggle now going on is one of life or death, and that the yoke of Fascism would not only turn the collective farmer into a serf under a German landlord, but would deprive the Soviet scientist of his freedom for creative work and of the joy of serving his country and world culture. It is this realization that powerfully spurs our scientists onward.

In peacetime it may occasionally have been possible to censure our scientists for not being invariably able to direct their work into channels most useful for the practical needs of our national economy. It may have been possible to reproach them for that academic abstraction, a hangover of the past, which sometimes marked the scientific work of some researchers. But now the threat to their freedom and their desire to save their country has inspired our scientists and directed their efforts toward the solution of present-day tasks. They are all striving urgently to supply answers to the questions put to them by the war.

Thus, several of our mathematicians who before the war occupied themselves with profound and abstruse problems of mathematical theory, that held meaning only for a small number of contemporary persons, have now successfully centered their attention on immediate problems. One such problem is the application of the conclusions of the modern mathematical theory of probability to the calculation of trajectories of projectiles in flight, thereby improving the accuracy of gunfire.

The wartime work of Soviet scientists may be classified by trends. Some are engaged on problems of broad national-economic significance—the study of sources of raw materials, of substitutes, of utilization of waste products, etc. This work is of particular importance now when we have temporarily lost some of our raw material sources and have had to shift our principal industries far to the east. A special commission of the Academy of Sciences, working at Sverdlovsk, has already achieved important results in this field.

War conditions limit the utilization of some of our resources and prevent importation of many raw materials. To make up the deficiencies with substitute materials is a huge task, mainly handled by our chemists. As an example I cite balsam salve. It is well known that importation of Peruvian balsam—an important component of the Vishnevski curative salves familiar to thousands of our wounded men—involves many difficulties. At present, one of the institutes of the Academy of Sciences is experimenting with a synthetic substitute of which there is no shortage. There is reason to believe its curative properties are not inferior to those of Peruvian balsam.

In another field, our scientists are giving counsel to industry to help it bring its productive forces into full play, to improve the technology of production, to increase output and make more rational use of resources of raw materials. This work comprises no small part of the efforts of our scientists, who frequently pay consultative visits to factories. The scope and multiformity of this work are so great that its full significance is often difficult to appreciate.

Lastly, our scientists are directly participating in the improvement of armaments and defense methods. Stalin has said that our tanks and airplanes are not inferior to the tanks and planes of the enemy. This fact by itself is extremely significant. It is well known that our aircraft industry is still quite young, having been practically non-existent before the Revolution. At first we naturally had to study and copy the achievements of the west in this domain. But we rapidly passed beyond the copying stage, and our aircraft industry long since stepped out on the path of independent, creative enterprise.

To say that Soviet scientists played a decisive role in the success of our aviation is not an exaggeration. After all, the qualities of a modern airplane depend almost entirely on the ability to calculate the profile of the wings and fuselage so that in flight the craft will present least resistance to the air. Experience shows that the slightest deviation from theoretically calculated profiles can considerably reduce flying qualities. These calculations are among the most exacting and interesting of modern aerodynamics. The theoretical work done in this regard by the group of young Soviet scientists produced by the school of Zhukovski and Chaplygin has in many respects left Western European researchers considerably behind. Without these achievements our planes, which have enabled our airmen to beat off the enemy's best squadrons so successfully, could never have existed.

Our scientists are well aware that in producing armaments they must not rest on their laurels for a single moment, that only constant improvement of our weapons brings the hour of final victory nearer and reduces the number of sacrifices that must be made before it is achieved. Boundless possibilities open for scientific thought in this domain. Our science is making use of these possibilities, enhancing the defensive strength of our country. It would be

difficult to enumerate all the major and minor undertakings launched in this field and which are already yielding results, even if it were possible to talk about them now.

It is interesting to note that there is not a single field of scientific thought that can not be of value in modern warfare. There is no specialty whose representatives can not put their attainments at their country's service. Physiologists are confronted with such new problems as improving the sight of observers and studying the effects of certain diets and drugs. A peaceful study such as the deciphering of cuneiform inscriptions proved to be of service when it was shown in the last war that experts in cuneiform and hieroglyphic writing were best equipped to decode secret enemy ciphers. Our botanists are working out rules for camouflage, taking account of seasonal changes in vegetation. Our historians are successfully helping fight the unprincipled pseudo-scientific propaganda of the fascists.

The struggle now being waged is giving an exceptional stimulus to scientific thought. The strain and tension caused by war are exposing the weak spots in our economy, technique and organization, showing the points where the state must first of all be assisted, and clearly formulating the demands which society makes on science. Although the war demands great sacrifice and causes much devastation, the upsurge of scientific work which is taking place in our country, and which must develop still more, will not lose its value after the war. The new war-revealed possibilities for unified development of our technique and economy will continue evident in the post-war period as well. History proves that this is true.

It is generally known, for instance, that when the Continental blockade cut France off from the colonies which had supplied it with cane sugar, Napoleon ordered his scientists to search for new sugar sources. Systematic work by French scientists led to the discovery of the method for extracting sugar from sugar beets, now the most widely used method. During the war of 1914–18, the process of nitrogen fixation was introduced and used on a large scale in Germany, which had suffered an acute nitrate shortage. The inventor Haber had not been able to find an industrial application for his discovery before the war. Germany was saved from speedy defeat and, after the war, the synthesis of ammonia spread throughout the world, serving as a basis for obtaining one of the best agricultural fertilizers.

In the course of the present war a number of similar achievements may undoubtedly be expected. For obvious reasons it is impossible to indulge in concrete discussion of the scientific work being carried on in the Soviet Union at the present time. It is already clear, however, that the war will lead to further improvement of our air fleet, will make for better motors, will teach us to achieve high productivity in industry with less workers, and will bring our theoretical, creative thought closer to the practical needs of the country. The sum total of the achievements of our Soviet land will have a tremendous bearing on the development of scientific thought serving world civilization.

OBITUARY

FRANK SMITH

1857–1942

FRANK SMITH, professor emeritus of zoology at the University of Illinois, died at St. Petersburg, Florida, on February 3, 1942, at the age of eighty-five years. He was born at Winneconne, Wisconsin, on February 18, 1857, son of Samuel Franklin and Aurelia Shepard Smith. The parents were of English origin, their ancestors having come to New England at a very early date. When the boy was two years of age his parents moved to New England. His early education was secured in public and private schools of Trenton, New Jersey. In 1870 the family returned to Wisconsin, and until the age of eighteen he attended the Winneconne village school. A marked mathematical turn of mind manifested itself at a very early age. At the age of twenty-one he began earning money to finance a college education. During the years 1879–1885 he was a student, first, in the preparatory department and, later, in the college department of Hillsdale College, Hillsdale, Michigan, receiving the Ph.B. degree in 1885, also the graduating prize in mathematics. While a student in this college he taught mathematics in the preparatory department during the years 1882–1886. A part of the summer of 1886 and the summer of 1887 were spent at the Marine Biological Station at Annisquam, Massachusetts, and the summer of 1891 at the Marine Laboratory of Alexander Agassiz at Newport, Rhode Island.

Following graduation he was appointed professor of chemistry and biology at Hillsdale College, occupying this position during the period 1886–1892. On September 8, 1887, he was married to Edith M. Fox, who died on November 15, 1888. One child, Donald Fisk Smith (1888–1905), was born to them. On July 12, 1890, he was married to Isadora Stamats, who survives him.

Finding his interest in biology growing and feeling the need of further training he did graduate work at Harvard University for a part of the years 1891 and

1893, receiving the degree of A.M. in 1893. In 1892 he was made instructor in biology at Trinity College, Hartford, Connecticut. The next year he was called to the University of Illinois as instructor in zoology. In 1896 he was made assistant professor; associate professor in 1906, and professor in 1913. During the period 1900–1917, he was also curator of the University Museum of Natural History. He taught in summer sessions of biological stations as follows: University of Illinois, 1898 and 1910; University of Michigan, 1911–1914 and 1919–1922; University of Colorado, 1916. The honorary degree of D.Sc. was conferred upon him in June, 1923, by Hillsdale College. In accordance with the University of Illinois retirement plan he became professor emeritus in 1926. He then returned to Hillsdale, Michigan, to live, although all but three of the subsequent winters were spent at St. Petersburg, Florida.

Professor Smith's career as a zoologist began when biology in America was still in its pioneer stage and he lived through that phenomenal period of growth of the science which led to its present maturity. It was a period of rapid change in materials and methods of teaching, scientific techniques and fields of research. To hear him give a connected account of this evolution of biology in America was a unique and informative experience.

The first serious research was begun at Harvard University under the guidance of E. L. Mark and resulted in a paper on the gastrulation of *Aurelia flavidula* (1891, *Bull. Mus. Comp. Zool.*). Events occurred shortly thereafter which changed markedly the character of his investigations. He was invited to become a member of a field party maintained, during the summer of 1893, by the Michigan Fish Commission to carry on a biological investigation of Lake St. Clair. This work marked the beginning of his permanent interests in the problems of inland waters. These interests became further crystallized when in the autumn of the same year S. A. Forbes induced him to go to the University of Illinois on a joint appointment between the Department of Zoology and the Illinois State Laboratory of Natural History. In the spring of 1894 he was made director of the newly organized Biological Station on the Illinois River, an institution jointly supported by the university and the state laboratory for the purpose of making faunistic studies in which special attention was given to the problems of the fisheries. It soon became evident that annelid worms were an important element in the fauna, but since little was known about them in North America, he began investigations on the Oligochaeta and thus his major field of research was initiated. In it he came to be the leading authority in America. His many contributions form the bulk of what is now known of the taxonomy, morphology, distribution and biological relations of the higher Oligochaeta of this continent.

Professor Smith also found other outlets for his diversified zoological interests. About 1915 he began researches on fresh-water sponges, publishing several valuable papers and building up an extensive collection. During a period of twenty years, beginning with 1903, he carried on investigations on the birds of eastern Illinois, with special attention to the relation of spring migration to weather conditions. Several papers were published in this field. Certain other research interests yielded publications, namely, structure of the sacrum and first haemal arch of *Necturus*, hydroids in the Illinois River, relation of fish to oxygen distribution and fresh-water medusae. In addition, there were other writings, such as the well-known chapters on fresh-water Hydrozoa and aquatic Oligochaeta in Ward and Whipple's "Fresh-water Biology."

One of the outstanding characteristics of Professor Smith as an investigator was his meticulous care in the testing of data, his rigorous scrutiny of literature and his insistence that research papers be composed with the utmost regard for accuracy, clarity and brevity. Another characteristic was his unflagging interest in research, manifesting itself in the steady flow of contributions throughout his professional career. Time gaps of any consequential size between contributions are lacking, even during that earlier period when he was afflicted with a serious impairment of eyesight.

As a teacher he was unusually stimulating in an individualistic way which was a part of his personality. Of particular strength was his organization and conduct of field work as a part of courses of instruction. It was his work which early effected an intimate association of the teaching program at the university and researches of the various scientific agencies of the state. He was also responsible for the early appreciation of the value of a museum in the university for teaching purposes rather than for popular exhibition.

As a member of the faculty, he served his university in many important ways. He was entrusted with university responsibilities which called for clear insight and sound judgment. Among his various services to other institutions, he acted for many years as consulting specialist to the U. S. National Museum and to the U. S. Department of Agriculture.

After retirement he found, much to his regret, that conservation of strength and lack of technical facilities necessitated abandonment of research on Oligochaeta. He then turned to his ornithological interests and entered upon an active program of bird banding. This activity, together with a deep interest in the development of the arboretum of Hillsdale College, was a constant source of interest and satisfaction. During the winter months in Florida, he became absorbed

in the intriguing ornithology of that state and was active in ornithological organizations at St. Petersburg. For ten years prior to his death he was a member of the board of trustees of Hillsdale College.

Professor Smith's personality was one in which unusual modesty, kindly reserve, deep sincerity and rigid honesty were outstanding features. His code of honorable living was the highest and never deviated. New acquaintances and friendships were acquired slowly and discriminatingly. He had scant patience with the thoughtless, frivolous and superficial, although he possessed a large portion of charity and never refused aid or a courteous hearing to those who approached him for assistance. His attitude towards friends and acquaintances was always charitable and kindly. For careless scientific work he had a supreme contempt and was not reluctant to condemn it in terms which it deserved. At times the undergraduate student stood much in awe of him, but his graduate students, in their more intimate relations, found in him a keen sense of humor, a warm friendliness and a generous sympathy. Those who enjoyed the privilege of the close contacts of a personal friendship had an opportunity to see the real meaning of superior personal honor and integrity.

PAUL S. WELCH

UNIVERSITY OF MICHIGAN

DEATHS AND MEMORIALS

DR. RAYMOND DODGE, professor emeritus of psychology at Yale University, died on April 8, at the age of seventy-one years.

DR. LORRAIN S. HULBURT, emeritus professor of collegiate mathematics at the Johns Hopkins University, died on March 29, at the age of eighty-four years.

DR. WILLIAM WEIDMAN LANDIS, for forty-seven years professor of mathematics at Dickinson College, died on April 8 at the age of seventy-three years.

DR. SUSAN R. BENEDICT, professor emeritus of mathematics at Smith College, who was a member of the faculty for thirty-six years, died on April 8. She was sixty-eight years old.

DR. HARRY A. CARPENTER, specialist in science in the schools of Rochester, N. Y., died on April 5, at the age of sixty-four years.

EDGAR W. TIMM, research assistant in genetics at the Iowa State College, died suddenly on March 28. He had been a Rhodes Scholar at the University of Oxford for three years, 1936–39, before returning to Iowa State, where he worked on bacterio-genetics. He was twenty-six years old.

A BUST of the late Henry Fairfield Osborn, president of the American Museum of Natural History, New York City, was unveiled in the Roosevelt Memorial Building on April 8. Addresses were given by Dr. William K. Gregory, professor of vertebrate paleontology at Columbia University and curator at the American Museum, who for many years cooperated with Dr. Osborn in his scientific work, and by Dr. James Rowland Angell, president emeritus of Yale University, educational director of the National Broadcasting Company.

SCIENTIFIC EVENTS

CHEMICAL WARFARE COURSE

TWENTY-FIVE physicians from the First, Second and Third Defense Regions attended a special course on "Medical Aspects of Chemical Warfare Agents" at the University of Cincinnati College of Medicine, from February 23 to 26, inclusive, under the auspices of the Medical Division of the Office of Civilian Defense with the cooperation of the Chemical Warfare Service of the U. S. Army. It is expected that the class will be repeated for physicians of other regions in the coming months.

Dr. Leon Goldman, assistant professor of dermatology and syphilology in the college of medicine and attending dermatologist at Cincinnati General Hospital, is in charge of the course. The faculty and the subjects given in the first course are as follows:

Milan A. Logan, Andrew Carnegie professor of physiological chemistry and head of the department: Review of Some of the Pertinent Data of the Chemistry of the Chemical Warfare Agents, and Medical Aspects of Some of the Systemic Poisons.

Dr. Robert A. Kehoe, research professor of physiology in the college and director of the Kettering Laboratory of Applied Physiology: Pathologic Physiology and Symptomatology of the Pulmonary Irritants, and Medical Aspects of some of the Systemic Poisons.

Dr. Marion A. Blankenhorn, Gordon and Helen Hughes Taylor professor of medicine: Therapy of Pulmonary Irritant Cases.

Dr. Willard Machle, research associate in applied physiology in the college and assistant director of the Kettering Laboratory: Individual Protection.

Dr. Albert L. Brown, assistant professor of ophthalmology: Eye Injuries from Chemical Warfare Agents.

Dr. Mont R. Reid, Christian R. Holmes professor of surgery: Treatment of Burns from Incendiaries and Other Materials.

Dr. James H. Bennett, assistant professor of surgery in anesthesia: Anesthesia for Chemical Warfare Casualties.

Dr. I. Arthur Mirsky, assistant professor of biological chemistry at the college and director of the May Institute of Medical Research at the Jewish Hospital: Medical and Chemical Aspects of Collective Protection.

Dr. Goldman: Vesicants: Brief Survey of Medical Aspects of the Irritant Smokes, Screening Smokes and Tear Gases; Medical Aspects of Collective Protection and of Decontamination; Medical Aspects of Protection of Food and of Water Supplies and of the Protection of Animals.

Lieutenant A. L. Sparks, of the staff of the Medical Research Laboratory, Chemical Warfare Service, Edgewood Arsenal, Md.: Military Aspects of Chemical Warfare as Related to Civilians.

Dr. George Baehr, chief medical officer, U. S. Office of Civilian Defense, Washington, D. C., gave the opening lecture of the course, explaining its purpose. It is intended that physicians who have taken this course will be able to set up similar units of instruction in their own localities and will teach both medical and civilian groups.

THE MEMPHIS MEETING OF THE AMERICAN CHEMICAL SOCIETY

THE annual meeting of the American Chemical Society will be held in Memphis, Tenn., on April 20, 21, 22 and 23. The Hotel Peabody has been designated as headquarters. Registration will begin on Saturday, continuing through Monday.

The proceedings will open with a general meeting in the Municipal Auditorium. The Honorable Walter Chandler, mayor of Memphis, will give the address of welcome. His address will be followed by the presentation of diplomas certifying to fifty years of continuous membership in the American Chemical Society to Leo H. Baekeland, G. E. Barton, Walker Bowman, Harold H. Fries, Walter Mills Saunders, Albert L. Smith, Alfred Springer, C. P. Van Gundy, Homer Jay Wheeler and Fred G. Zinsser.

The Eli Lilly and Company Award in Biological Chemistry will be presented to Earl Alison Evans, Jr. His address will be delivered on Wednesday before the Division of Biological Chemistry. He will speak on "Carbon Dioxide Assimilation in Animal Tissues." The Borden Award in the Chemistry of Milk will be presented to George E. Holm, who will give the award address, entitled "The Physical and Chemical Aspects of the Libides in Milk," before the Division of Agricultural and Food Chemistry on Thursday.

The following lectures are planned: Henry G. Knight, U. S. Bureau of Agricultural Chemistry and Engineering, on "Cotton—Yesterday, To-day and Tomorrow"; Colonel A. Gibson, Chemical Warfare Service, inspector, Office of Civilian Defense, on "The Chemist's Place in Civilian Defense." Lawrence W. Bass, Mellon Institute of Industrial Research, chairman of the American Chemical Society Committee on Economic Status, will read the report of the committee. There will also be presented from the Office of Civilian Defense Training a motion picture entitled "Fighting the Fire Bomb."

Practically all the divisions of the society will present technical programs throughout the week, and a number of symposia and joint meetings of the divisions are planned. Symposia have been arranged on The Hydrogen Bond and Related Topics, Rare Earths, Trace Elements in Nutrition, Vitamins, Analytical Methods in Organic Chemistry and the History of Chemistry in the South. There will be a round table on the teaching of chemistry on Tuesday afternoon and a student program all day on Wednesday.

There will be trips of inspection to various plants, but these have been greatly curtailed because of the war. Many industries can not permit inspection trips and others must limit attendance in order to avoid interference with production.

THE SCIENTIFIC MEETINGS AT SALT LAKE CITY

THE following societies will meet in cooperation with the Pacific Division of the American Association for the Advancement of Science, which will hold its twenty-sixth annual meeting at Salt Lake City from June 15 to 20:

American Association of Economic Entomologists, Pacific Slope Branch, *chairman*, G. F. Knowlton, Utah State Agricultural College, Logan; American Association of Physics Teachers, *president*, A. A. Knowlton, Reed College, Portland, Oregon; American Chemical Society, Pacific Intersectional Division, *chairman*, W. D. Bonner, University of Utah, Salt Lake City; American Geophysical Union, Section in Hydrology, *chairman in charge of arrangements*, Royce J. Tipton, Denver, Colorado; American Meteorological Society, *president*, E. H. Bowie, U. S. Weather Bureau, San Francisco, California; American Phytopathological Society, Pacific Division, *president*, R. B. Streets, University of Arizona, Tucson; American Society for Horticultural Science, Western Section, *chairman*, A. C. Hildreth, U. S. Department of Agriculture, Cheyenne, Wyoming; American Society of Ichthyologists and Herpetologists, Western Division, *president*, Margaret Storey, Natural History Museum, Stanford University; American Society of Plant Physiologists, Western Section, *chairman*, J. Van Overbeek, California Institute of Technology, Pasadena; Association of Pacific Coast Geographers, *president*, Forrest Shreve, Desert Laboratory, Carnegie Institution of Washington, Tucson; Botanical Society of America, Pacific Division, *president*, C. E. Owens, Oregon State College, Corvallis; California Academy of Sciences, *president*, F. M. MacFarland, Stanford University; Ecological Society of America, Western Section, *president*, C. F. Korstian, Duke University, Durham, North Carolina; Oceanographic Society of the Pacific, *president*, R. C. Miller, California Academy of Sciences, San Francisco; Society of American Bacteriologists, Southern California Branch, *chairman*, Anson Hoyt, Medical School, University of Southern California, Los Angeles; Society for Experimental Biology and Medicine, Pacific Coast Branch, *chairman*, C. A. Kofoid, department of zoology, University of California, Berkeley; Western

Interstate Snow Survey Conference, *chairman in charge of arrangements,* George D. Clyde, Utah State Agricultural College, Logan; Western Society of Naturalists, *president,* G. H. Ball, University of California, Los Angeles; Western Society of Soil Science, *president,* L. C. Wheeting, State College of Washington, Pullman.

ELECTIONS TO FELLOWSHIP OF THE ROYAL SOCIETY

ELECTIONS to fellowship of the Royal Society, London, on March 19 are as follows:

Burn, J. H., professor of pharmacology, Oxford; formerly dean of the College of the Pharmaceutical Society; distinguished for his work in physiology and pharmacology and on the principles and methods of biological standardization.

Burnet, F. M., assistant director of the Walter and Eliza Hall Institute for Medical Research, Melbourne; distinguished for his researches in bacteriology, especially on avian and mammalian viruses.

Dixon, M., lecturer in biochemistry, Cambridge; distinguished for his work on tissue respiration and respiratory catalysis.

Dodds, E. C., professor of biochemistry, Middlesex Hospital Medical School; distinguished for his investigations in biochemistry in relation to physiology and medicine and especially in the synthetic production of oestrogenic agents.

Fage, A., principal scientific officer, Aerodynamics Department, National Physical Laboratory; distinguished for his contributions to the experimental study of aero- and hydrodynamics, particularly in relation to turbulent flow.

Fairley, N. H., consulting physician in tropical diseases; Colonel, A.A.M.C.; physician and director of special research, Hospital for Tropical Diseases, London; distinguished for his researches in tropical medicine.

Hall, P., university lecturer in mathematics, Cambridge; distinguished for his contributions to pure mathematics, particularly in the theory of groups.

Hanes, C. S., senior scientific officer, Low Temperature Research Station, Cambridge; distinguished for his researches in botany and biochemistry, and particularly for the first enzymatic synthesis of starch.

Henderson, G. H., professor of mathematical physics, Dalhousie University, Halifax; distinguished for his work in radio-activity and particularly in the investigation of pleochroic haloes.

Hilditch, T. P., professor of industrial chemistry, Liverpool; distinguished for his work on the chemistry of natural fats.

Hindle, E., regius professor of zoology, Glasgow; distinguished for his work in parasitology, and on the cytology of artificial parthenogenesis.

Holmes, A., professor in geology, Durham; distinguished for his work in petrology and the applications of radioactivity to geological problems.

Newitt, D. M., assistant professor in chemical technology, Imperial College, London; distinguished for his work on high pressure technology and for his researches on combustion.

Paterson, C. C., director of the Research Laboratories, General Electric Company, Wembley; distinguished for his work in promoting physical and industrial research.

Roberts, J. K., assistant director of research, Colloid Science Laboratory, Cambridge; distinguished for his investigations by physical methods on adsorption and other surface phenomena of importance in catalysis.

Skinner, H. W. B., Wills research fellow and lecturer in spectroscopy, Bristol; distinguished for his work on the x-ray spectroscopy of the solid state leading to results of importance in the theory of the structure of metals.

Thoday, D., professor of botany, Bangor; distinguished for his researches in plant physiology, particularly those dealing with photosynthesis, causal anatomy and the water relations of plants.

Todd, A. R., professor of chemistry, Manchester University; distinguished for his researches in organic chemistry, notably the synthesis of vitamin B_1 and other natural compounds of physiological importance.

Trueman, A. E., professor of geology, Glasgow; distinguished for his work in paleontology, particularly on the molluscan faunas of the coal measures.

Wilson, A. H., university lecturer in mathematics, Cambridge; distinguished for his contributions to the electronic theory of solids and for his work on the properties of metals.

MEDAL DAY AT THE FRANKLIN INSTITUTE

Two men whose contributions to science have had their influence upon our war industries were among those honored by the Franklin Institute at the annual Medal Day exercises on April 15.

Dr. Jerome Clarke Hunsaker, general coordinator of the Naval Research and Development Board and chairman of the National Advisory Committee for Aeronautics, received the Franklin Medal for his distinguished contributions to aeronautical research and development. Dr. Hunsaker designed the NC type of flying boat which made aviation history on its transatlantic flight in 1919. He also designed the *Shenandoah,* the first large airship to be built in this country, and has played a conspicuous part in the later developments of technical advancement of aviation.

A second Franklin Medal was presented to Dr. Paul Dyer Merica, vice-president of the International Nickel Company of Canada. Dr. Merica has received world-wide recognition for his work in the hardening of alloys and in the development of heat treatment of alloys, so that they have an increased usefulness in the industrial field. His preeminence in the field of metallurgy is as much due to his success in adapting many alloys to commercial purposes as to his discovery of the principle of precipitation hardening, a principle of the utmost importance in these days when alloys find a multitude of applications in diversified war industries.

Honorary membership of the institute was conferred upon Senator George Wharton Pepper "in

consideration of his inspiring leadership in the movement to reincarnate in our time the homely virtues" of Benjamin Franklin.

Pure science was recognized in the awards of the Elliott Cresson Medals to Dr. Claude S. Hudson, of the National Institute of Health, and to Dr. Isidor I. Rabi, of Columbia University. The former thus receives recognition for his distinguished investigations into the chemistry of sugars, which has greatly enriched our knowledge of the subject. Dr. Rabi receives the award for the development of the Rabi magnetic resonance method of investigating the nucleus of the atom.

Awards of the Longstreth Medal, for an ingenious construction of a thread grinding machine, were made to Ralph E. and Ernest V. Flanders and to Charles Maxwell Kearns for the application of methods for measuring strains in aircraft propellers under flight conditions.

The frequent uses of concrete in structural work gives importance to the research of Duff A. Abrams, who discovered the fundamental bases for concrete and reinforced concrete mixtures. Mr. Abrams received the Frank P. Brown Medal in recognition of his work.

Three Howard N. Potts Medals were awarded: To Dr. Jesse W. Beams, for his contributions to the problems of high-speed rotation which have met with many applications in the development of ultra-high-speed centrifuges; to Harcourt C. Drake, for the development of a rail fissure detection car which has done much to reduce loss of life and property on railroads, and to Dr. Bernard Lyot, the French astronomer, for his method of studying the sun's corona in the absence of a total eclipse.

The Louis E. Levy Medal for the best paper to appear in the *Journal of The Franklin Institute* has been awarded for the year 1941 to Dr. John Donovan Strong, of the California Institute of Technology, for his paper entitled "On a New Method of Measuring the Mean Height of Ozone in the Atmosphere."

Certificates of Merit were awarded to the Goodyear Tire and Rubber Company for their production of an improved safety tire; to Dr. John J. Grebe, inventor of an ingenious metal sun blind, and to Walter Larkin, of Philadelphia, for an admirable design of a circular knitting machine.

The awards were presented by Charles S. Redding, president, at the meeting of the Franklin Institute on April 15. Senator George Wharton Pepper spoke on "Franklin as a Guide in Our Affairs of To-day" at the annual dinner, which was held in the evening.

SCIENTIFIC NOTES AND NEWS

PROFESSOR FREDERICK G. KEYES, head of the department of chemistry and director of the research laboratory of physical chemistry at the Massachusetts Institute of Technology, has been awarded the 1942 Theodore William Richards Medal of the Northeastern Section of the American Chemical Society for "distinguished achievement in chemistry."

THE annual medal of the American Institute of Chemists, awarded for "outstanding service to the science of chemistry and the profession of the chemist in America," will be presented on May 16 at the Claridge Hotel, Atlantic City, N. J., to Professor William Lloyd Evans, emeritus professor of chemistry at the Ohio State University, president in 1941 of the American Chemical Society.

DR. LEO LOEB, emeritus professor of pathology at the School of Medicine of Washington University, St. Louis, was presented on March 3 with the Award of Merit and Gold Medal of the St. Louis Medical Society.

RENO H. SALES, chief geologist of the Anaconda Copper Mining Company, Butte, Mont., has been awarded for distinguished engineering achievement the 1942 Egleston Medal of the Columbia University Engineering Schools Alumni Association. It will be presented to him at the seventy-first annual dinner of the alumni on April 23.

THE honorary doctorate of laws was conferred on February 23 on commemoration day at the Johns Hopkins University on Dr. Ross Granville Harrison, chairman of the National Research Council and Sterling professor of biology, emeritus, at Yale University; on Dr. Frank R. Lillie, emeritus professor of zoology and embryology at the University of Chicago, and on Dr. Henry A. B. Dunning, director of the research laboratory and president of Hynson, Westcott and Dunning, Inc.

PROFESSOR C. LOVATT EVANS, F.R.S., Jodrell professor of physiology at University College, London, has been elected an honorary member of the Sociedad Argentina de Biologia.

IT is stated in *Nature* that the Committee of the Athenaeum, London, under the provision which empowers the annual election of a certain number of those of distinguished eminence in science, literature or the arts, or for their public services, has elected to membership Professor P. M. S. Blackett, Langworthy professor of physics, University of Manchester, and T. D. Kendrick, keeper of British and Medieval Antiquities, British Museum.

AT the recent New York meeting of the American Society for the Control of Cancer, officers were elected as follows: Dr. Herman C. Pitts, Providence, R. I., *President;* Dr. Frank E. Adair, New York, *Vice-president;* Dr. Cornelius P. Rhoads, New York, *Secretary;* James H. Ripley, New York, *Treasurer,* and Dr. Clarence C. Little, Bar Harbor, Maine, *Managing Director.*

IT is announced that Dr. Edward W. Berry, professor of paleontology at the Johns Hopkins University, will retire as dean and provost of the university in order to devote more time to his scientific work. He has been dean of the College of Arts and Sciences since 1929 and provost since 1935. He will continue as professor of paleontology. Dr. G. Wilson Shaffer, professor of physical education, has been named acting dean of the College of Arts and Sciences, and P. Stewart Macaulay, secretary of the university, has been appointed provost. These appointments will become effective in October when Dr. Berry retires.

THE *Journal* of the American Medical Association states that Dr. Leslie L. Bigelow, clinical professor of surgery at the Ohio State University College of Medicine, Columbus, has been appointed acting dean of the school. He succeeds Dr. Hardy A. Kemp, dean since September 1, 1941, who as a major in the medical reserve corps of the U. S. Army has been called into active service at the Army Medical School, Washington, D. C.

ALBERT EIDE PARR, professor of zoology at Yale University and director of the Peabody Museum, has been elected director of the American Museum of Natural History, New York, to succeed Dr. Roy Chapman Andrews, whose resignation takes effect on June 1. Mr. Parr was formerly scientific director of oceanographic expeditions at Yale University and is now director of marine research.

T. ROY REID, who has served as chief assistant to Secretary of Agriculture Claude R. Wickard, has been named director of personnel for the U. S. Department of Agriculture.

LIEUTENANT COLONEL THOMAS B. TURNER, Medical Reserve Corps, U. S. Army, professor of bacteriology at the Johns Hopkins School of Hygiene and Public Health, has been ordered to active duty in the Surgeon General's Office, Washington, D. C., as chief of the subdivision of venereal disease control.

DR. MARCUS S. GOLDSTEIN, research fellow of the Institute for Latin-American Studies at the University of Texas, has returned from a three months stay in Mexico, where a check sample of families was obtained following a study in Texas of the physical anthropology of Mexican families and their American-born descendants.

The Experiment Station Record states that Dr. Lindsey A. Brown, associate agronomist in charge of soil surveys at Colorado State College and Experiment Station, has leave of absence for a year to become special consultant in soils with the Farm Security Administration at Denver, of the U. S. Department of Agriculture. His work at Colorado has been taken over by Dale S. Romine, instructor and assistant in soils.

R. A. BUTLER, president of the British Board of Education, has been made chairman of the Scientific Advisory and Engineering Advisory Committees in succession to Lord Hankey.

DR. B. E. DAHLGREN, chief curator of the department of botany of Field Museum, Chicago, has returned from a brief collecting trip to Cuba undertaken for the purpose of adding to the palm herbarium. He also investigated potential sources of economic plant products.

DR. JAMES M. MACKINTOSH, professor of public health at the University of Glasgow, has returned to Scotland after spending several months in the United States as the guest of the Rockefeller Foundation. Dr. Mackintosh, who was from 1937 to 1941 chief medical officer of the Department of Health for Scotland, acted as consultant to the Medical Division of the Office of Civilian Defense, Washington, D. C., and in that capacity visited many parts of the United States, lecturing and advising on Emergency Medical Service for Civilian Defense.

THE annual Christian A. Herter lectures at the New York University College of Medicine were delivered on April 6 and 7 by Dr. Conrad A. Elvehjem, professor of biochemistry at the University of Wisconsin.

DR. WALLACE W. ATWOOD, president of Clark University and founder of the Graduate School of Geography, lectured at the University of Texas on April 9 and 10. He spoke on "The Geography of Colorado" and on "The Geography of China."

EACH year the Sigma Xi chapter of the Iowa State College presents as speaker at one of the regular meetings a member of the staff who has made distinguished contributions to scientific research. In accordance with this custom, Dr. Alfred M. Lucas, associate professor of zoology at the college, has been chosen to address the society. He will speak on "The Effects of Viruses on Tissue Cells."

DR. LIONEL S. MARKS, professor of mechanical engineering, emeritus, Graduate School of Engineering, Harvard University, is delivering during April a Sigma Xi lecture at a number of colleges and universities. They are the Polytechnic Institute of Brook-

lyn, West Virginia University, Washington University, the University of Nebraska, the University of Colorado, the Louisiana State University, the North Carolina State College, the University of North Carolina, Miami University, the University of Michigan and the Illinois Institute of Technology.

THE annual meeting of the American Psychological Association will be held at the Hotel Statler and at Harvard University on September 2, 3, 4 and 5, under the presidency of Dr. Calvin P. Stone, of Stanford University. His presidential address will be delivered on the evening of September 4. A panel discussion on "Psychology in Civilian Service," under the direction of Dr. Karl M. Dallenbach, of Cornell University, chairman of the Emergency Committee in Psychology, has been arranged for Wednesday, and on Friday a second panel discussion on "Psychology in Government Service" is planned under the chairmanship of President Leonard Carmichael, of Tufts College, director of the National Roster of Scientific and Specialized Personnel. Plans have been completed for the celebration of the fiftieth anniversary of the American Psychological Association and of the centennial of William James.

THE thirteenth annual meeting of the American Association of Physical Anthropologists was held at Harvard University on April 16, 17 and 18. The annual public address was given by Dr. R. C. Carpenter, on the "Behavior and Social Relations of the Rhesus Monkey" (with motion pictures). In addition to papers read before the sections, there were two symposia, one on "Present-day Aims and Interests in Physical Anthropology," presided over by Dr. E. W. Count, and one on "Techniques in Physical Anthropology," presided over by Dr. H. L. Shapiro.

THE annual joint meeting of the Wisconsin Museum Conference, the Wisconsin Academy of Science, Arts and Letters, the Wisconsin Archeological Society and the Wisconsin Folklore Society was planned for April 17 and 18 at the University of Wisconsin. All the state societies offered papers in the programs. The annual dinner was held at the University Memorial Union.

THE Medical Library Association will hold its forty-fourth annual meeting in New Orleans on May 7, 8 and 9. The hosts are the Rudolph Matas Medical Library of Tulane University, the Orleans Parish Medical Society Library and the Agramonte Memorial Library of Louisiana State University Medical Center. Hotel headquarters will be at the Jung Hotel. The program will feature tropical medicine and southern medical history. The president of the association, Miss Mary Louise Marshall, will preside.

IT is reported in *Nature* that the inaugural meetings of the newly formed optical group of the British Physical Society were held on March 6. It is ten years ago since the Optical Society was merged with the Physical Society, and although in this period a good number of meetings have been devoted to optical subjects, there has been a widely expressed desire for the formation of a group for discussions and lectures of a less exacting and critical character than those associated with papers intended as original contributions to science. A preliminary meeting was held in December, 1941, at which a draft constitution was approved. This was adopted at the inaugural meeting. Dr. A. O. Rankine was elected chairman and Dr. L. C. Martin was made honorary secretary.

THE U. S. Civil Service Commission announces further open competitive examinations for technologists, with salaries ranging from $2,000 to $5,600 a year. Applicants must not have passed their sixtieth birthday. Junior chemists to perform research, investigative or other work in some branch of chemistry also are needed. The positions pay $2,000 a year. Women especially are urged to apply. The Navy yards, arsenals and other Government laboratories are now employing women in chemical work. Completion of a four-year course in a recognized college with 30 semester hours in chemistry is required. Further information in regard to these positions can be obtained from the Civil Service Commission, Washington, D. C.

UNDER the will of the late Dr. Menas S. Gregory, formerly professor of psychiatry in the New York University College of Medicine, the sum of $40,000 is left to that institution. Twenty thousand dollars will be used to establish an annual lectureship and the balance will be given toward the endowment of a professorship in the department of psychiatry.

THE Indian Society of Genetics and Plant Breeding, which was established at New Delhi in January, has issued the first number of a new journal entitled the *Indian Journal of Genetics and Plant Breeding*. It is edited on behalf of the executive council of the society by Dr. B. P. Pal, Imperial Agricultural Research Institute, New Delhi.

ACCORDING to the *Journal* of the American Medical Association the new Churchill Hospital is to be opened at Oxford. It will be administered by a group of American surgeons who arrived in England on the first day of the air raids on London. The hospital was built in 1941 and therefore is the first to be built with the horrors of modern warfare in mind. It is so designed that a bomb could do no great damage to the hospital as a whole. The wards are built round a courtyard, each ward having its own air raid shelter. Six hundred patients can be accommodated. The staff comprises twelve American doctors and fifty American and Canadian nurses. Its main function will be

reconstruction, of which the two branches will be orthopedic and plastic. A medical service and other types of surgery will be provided as necessity arises. After the war it is intended, if possible, to keep the hospital as a permanent American hospital in relation with the Oxford Medical School. It is hoped that a similar British organization may be initiated in relation with a university in the United States.

DISCUSSION

CYTOCHROME B_2

IN the course of isolation of cytochrome *c* reductase from yeast,[1] the presence of a new hemin compound was reported. This observation is of particular interest now because of the report of Bach, Dixon and Keilin[2] of the discovery of a new cytochrome b_2, which, from spectrometric evidence, seems to be identical with the one we have reported. These investigators ascribe two bands to the compound, one at 530 mμ and the other at 557 mμ. The position of the Soret band was not given. The spectrum of an impure sample of cytochrome *c* reductase, both in the oxidized and reduced forms, is given in Fig. 1. In the

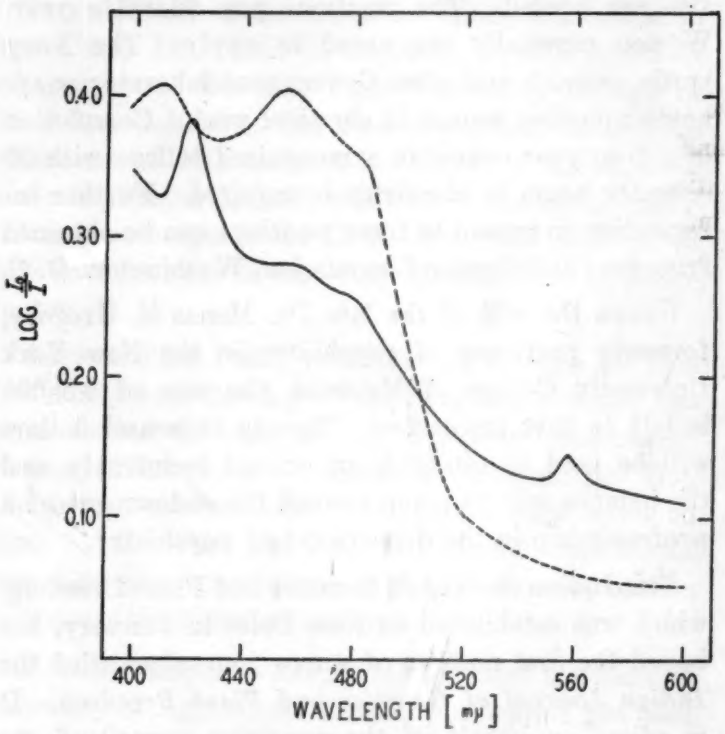

FIG. 1

reduced form the α band of the hemin compound which was present in our preparation was observed at 557 mμ and the Soret band at 420 mμ. Upon oxidation the α band disappears, whereas the Soret band shifts to 410 mμ. The peak at 455 mμ is that of the cytochrome *c* reductase.

This hemin compound is reduced by addition of hexose monophosphate, *Zwischenferment,* and triphosphopyridine nucleotide.

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FEB. 17, 1942

1 *Jour. Biol. Chem.,* 136: 747, 1940.
2 *Nature,* 149: 21, 1942.

ON THE WIDTH AND ORIGIN OF BACTERIAL FLAGELLA

THE writer was recently examining a photograph of *Aerobacter cloacae* taken with the electron microscope and released by the RCA Manufacturing Company[1] and was struck by its bearing on two controversial points regarding bacterial flagella, namely, the width of a single, unstained flagellum and its origin in the cell.

The thickness of a single, dried, unstained flagellum has been indirectly estimated for a number of bacteria (Migula,[2] Reichert,[3] Meyer[4]). The methods used were based on uncertain and objectionable assumptions. Therefore, one can not help but welcome the heretofore scanty material made available by the electron microscope and hope for more. Accurate measurement of the width of the flagellum of *A. cloacae* were made by drawing a scale, like the one previously used by the writer,[5] on transparent material and by properly superimposing the scale on the photograph of the flagellum. This gave a thickness of 0.02 μ, and an average ratio of 1/22 between the width of the dried flagellum and that of the dried cytoplasm. This ratio is about the same as the one estimated by Migula[2] and is at variance with Meyer's[4] ratio of 1/10. Whether this ratio will hold for other bacteria remains to be seen. Furthermore, by assuming that the faint outer zones of the cells shown in the photograph represent the cell walls, we are justified in assuming that their boundary represents the boundary of the living cells, and that the shrunken cytoplasm has, on the average, about three fourths of its original width (slightly higher than the two thirds found in the literature[6]). On this basis, the width of a single flagellum of *A. cloacae* in the living condition will be about 0.0267 μ or, roughly, 0.03 μ.

Regarding the origin of the flagellum, we have those who believe that it originates from the cell wall and those who believe that it originates in the cytoplasm and extends through pores in the cell wall. The literature has been reviewed by the writer.[6] In the above-

1 Wallerstein Laboratories Communications, 4: 3, 1941.
2 W. Migula, "System der Bakterien," 1, 96–138, Jena, 1897.
3 K. Reichert, *Centralbl. f. Bakt.*. I, Orig., 51: 14–94, 1909.
4 A. Meyer, "Die Zelle der Bakterien," 119–120, Jena, 1912.
5 G. Knaysi, *Jour. Inf. Dis.,* 45: 13–33, 1929.
6 G. Knaysi, *Bot. Rev.,* 4: 86–87 and 99, 1938.

mentioned photograph of *A. cloacae,* there is one cell that clearly shows penetration of the faint, outer zone by the flagella all the way to the shrunken mass of the cytoplasm. If this outer zone is the cell wall, and the writer has reasons to believe that it is, then the electron microscope has been instrumental in settling another controversial point regarding bacterial flagella.

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FLUOROCHEMISTRY

WITH the increasing number of researches and publications devoted to the applications of fluorescence to chemistry, a need is rapidly arising to identify this new branch of science as distinct and apart from related and often confused fields.

Therefore, it seems expedient to propose the name *fluorochemistry* as descriptive of this branch of science. The term fluorochemistry is in order with other terms created to identify highly specialized fields which are still within the boundaries of chemistry and/or physics, *e.g.,* photochemistry, physical optics, and so on.

JACK DE MENT

The Mineralogist,

PORTLAND, OREGON

SINO-AMERICAN SCIENTIFIC FRIENDSHIP

IN the January 3, 1942, issue of *Nature* there appeared a communication from the British Association of Scientific Workers to American men of science, calling attention to the numerous bonds between them and pointing out the necessity for further cooperation between them and, particularly, their Soviet colleagues in order to achieve the goal of "preserving the scientific heritage of the whole world against the barbarism and obscurantism of Fascist ideology." While the sentiments of this message are undoubtedly welcomed and shared by all American scientists and will strengthen our mutual friendship, we think it of the greatest importance to include and reemphasize at this time our continued feeling of solidarity with the scientific and technical workers of China who have given the world such a magnificent example in contributing to the effort of resistance against brutal aggression.

It has been the good fortune of this country that numerous Chinese have come to study with us and that close ties unite many of the educational institutions of China with our own. We have long admired for their qualities of high character, vigorous personality and intellectual ability the Chinese who have been our fellow classmates, students or professional colleagues. Working with them in our institutions here or in those of China we have realized that there is mutual understanding and that their contribution to civilization continues in an undiminished stream. Our esteem has grown even greater during the past years as we have witnessed the courage with which, in the invaded cities under scrutiny of the enemy or under more adverse physical conditions in the free cities which they have reached often only after long and perilous travel, they have persevered to increase the common store of knowledge as well as to aid in the resurgence of their nation.

We are certain that the scientific workers of Great Britain and Russia join wholeheartedly with us in expressing again to our Chinese colleagues the feeling of comradeship which for many years has motivated our relations and will in the future aid us to create a world where all men may work for the common good, free of threats to security and happiness.

MORRIS F. SHAFFER

QUOTATIONS

THE WORK OF THE ROCKEFELLER FOUNDATION IN 1941[1]

DURING 1941 the appropriations of the Rockefeller Foundation amounted to $9,313,964. The income of the foundation from investments during the year was $8,734,992. This income was supplemented by a transfer of $600,000 from the principal fund.

The appropriations were distributed for the most part in six major fields, roughly as follows:

Public health	$2,450,000
Medical sciences	2,120,000
Natural sciences	1,271,000
Social sciences	1,227,000
Humanities	1,020,000
Program in China	154,000

A detailed statement of the appropriations made in 1941 appears at the conclusion of this report. Of the money spent during the year, 74 per cent. was for work in the United States and 26 per cent. for work in other countries.

The war, of course, has radically affected the activities of the foundation abroad. In June, 1940, the foundation's Paris office was closed, and the Lisbon office was closed in July, 1941. There are now no foundation representatives on the continent of Europe, but an office is being maintained in London. Late in 1940 the Far Eastern office of the foundation

[1] Opening pages of the annual report of Dr. Raymond B. Fosdick, president of the Rockefeller Foundation.

was moved from Shanghai to Manila. At the time of the capture of Manila the head of the office, Dr. M. C. Balfour, was in Kunming. Unfortunately, his associate, Dr. Charles N. Leach, and some of the personnel of the Peiping Union Medical College who were on their way to the United States were in Manila when the city fell. The Peiping Union Medical College was closed by the Japanese authorities early in 1942 and the leading members of the staff were interned.

MAKING THE PRESENT SERVE THE FUTURE

Confronted with a world in which ruthlessness must be employed to destroy a far more dangerous kind of ruthlessness, organizations like the Rockefeller Foundation, dedicated to the extension of knowledge, can only reaffirm their undiscourageable belief in the ultimate power of reason. As Alvin Johnson says: "The rules of civilization, wrought out on Sinai and the Areopagus, . . . are prior to the bomber and poison gas, and will survive beyond them." The Bill of Rights will outlast "Mein Kampf" just as the scientist's objective search for truth will outlive all the regimented thinking of totalitarianism. Temporarily eclipsed, the proud names of Paris, Strasbourg, Prague, Louvain, Warsaw, Leyden, as well as of Heidelberg and Leipsic and Berlin, will once again stand for the quest for truth; once again will they be centers of candid and fearless thinking—homes of the untrammeled and unafraid, where there is liberty to learn, opportunity to teach and power to understand.

The task which faces all institutions concerned with the advance of knowledge is not only to keep this faith alive but to make certain, as far as they can, that the streams of culture and learning, wherever they may be located or however feebly they may now flow, shall not be blocked. In line with this latter function, in so far as circumstances and limited funds make possible, the Rockefeller Foundation conceives its principal role.

This concern for the future is a matter of stern, practical sense. The specialized talents and abilities that are meeting this emergency and those that will meet emergencies to come are not produced by feverish last-minute activities. No amount of pressure can suddenly create a supply of thoroughly trained and broadly experienced physicists, mathematicians, chemists, biologists, economists and political scientists. These men represent the trained intelligence without which a war can not be won, or a lasting peace achieved. They emerge spontaneously, unpredictably, but irresistibly out of long, patient and sustained effort. Pure research, the clean urge to gain new knowledge, the sympathetic appreciation of imaginative scholarship even when it seems remote and unrelated—these we must steadfastly sponsor or our vital intellectual resources will fail us in the days to come.

It is true, of course, that in an attempt to maintain long-range programs, aiming at the future rather than at the present, no institution can escape the urgencies of the moment. We are all of us in the war and it is idle to pretend that business can proceed as usual. A substantial proportion of the appropriations of the Rockefeller Foundation has some relation to the present emergency. For example, the foundation is furnishing yellow fever vaccine for the Army and Navy; it is speeding up its research in influenza, malaria and typhus, which have a vital bearing on the war; it has financed the microfilming of countless historical records in England that might be destroyed; it has given aid to the development of brain surgery necessitated by war wounds; it has tried to salvage as much of the scholarship of Europe as possible by bringing outstanding university men to the United States.

All this has to do with war or its results. And yet it is possible to say that this type of emergency help has invariably been related to the far target. In trying to be of service in the calamity that engulfs us all the foundation has endeavored to make certain, in so far as it could, that its work had some constructive reference to the world after the war. The development of brain surgery or of techniques for the control of specific diseases has significance for the future as well as for the present; much of the historical material of England is being opened to the students of other countries for the first time; the deposed scholars of Europe are enriching the intellectual life of America; the natural sciences, whether in physics or biology or chemistry, can and will be used to serve a world at peace as well as at war. In all the reordering of human life and habits which the war makes necessary it is still possible, not only in the field of the physical and social sciences, but in the humanities as well, to make the present serve the future.

THE SEARCH FOR UNITY

If we are to have a durable peace after the war, if out of the wreckage of the present a new kind of cooperative life is to be built on a global scale, the part that science and advancing knowledge will play must not be overlooked. For although wars and economic rivalries may for longer or shorter periods isolate nations and split them up into separate units, the process is never complete because the intellectual life of the world, as far as science and learning are concerned, is definitely internationalized, and whether we wish it or not an indelible pattern of unity has been woven into the society of mankind.

There is not an area of activity in which this can not be illustrated. An American soldier wounded on a battlefield in the Far East owes his life to the

Japanese scientist, Kitasato, who isolated the bacillus of tetanus. A Russian soldier saved by a blood transfusion is indebted to Landsteiner, an Austrian. A German soldier is shielded from typhoid fever with the help of a Russian, Metchnikoff. A Dutch marine in the East Indies is protected from malaria because of the experiments of an Italian, Grassi; while a British aviator in North Africa escapes death from surgical infection because a Frenchman, Pasteur, and a German, Koch, elaborated a new technique.

In peace as in war we are all of us the beneficiaries of contributions to knowledge made by every nation in the world. Our children are guarded from diphtheria by what a Japanese and a German did; they are protected from smallpox by an Englishman's work; they are saved from rabies because of a Frenchman; they are cured of pellagra through the researches of an Austrian. From birth to death they are surrounded by an invisible host—the spirits of men who never thought in terms of flags or boundary lines and who never served a lesser loyalty than the welfare of mankind. The best that every individual or group has produced anywhere in the world has always been available to serve the race of men, regardless of nation or color.

What is true of the medical sciences is true of the other sciences. Whether it is mathematics or chemistry, whether it is bridges or automobiles or a new device for making cotton cloth or a cyclotron for studying atomic structure, ideas can not be hedged in behind geographical barriers. Thought can not be nationalized. The fundamental unity of civilization is the unity of its intellectual life.

There is a real sense, therefore, in which the things that divide us are trivial as compared with the things that unite us. The foundations of a cooperative world have already been laid. It is not as if we were starting from the beginning. For at least three hundred years the process has been at work, until to-day the cornerstones of society are the common interests that relate to the welfare of all men everywhere.

In brief, the age of distinct human societies, indifferent to the fate of one another, has passed forever; and the great task that will confront us after the war is to develop for the community of nations new areas and techniques of cooperative action which will fit the facts of our twentieth century interdependence. We need rallying points of unity, centers around which men of differing cultures and faiths can combine, defined fields of need or goals of effort in which by pooling its brains and resources the human race can add to its own well-being. Only as we begin to build, brick by brick, in these areas of common interest where cooperation is possible and the results are of benefit to all, can we erect the ultimate structure of a united society.

A score of inviting areas for this kind of cooperation deserve exploration. Means must be found by which the potential abundance of the world can be translated into a more equitable standard of living. Minimum standards of food, clothing and shelter should be established. The new science of nutrition, slowly coming to maturity, should be expanded on a world-wide scale. The science of agriculture needs development, not only in our own climate but particularly in the tropic and subtropic zones. With all their brilliant achievements the medical sciences are in their infancy. Public health stands at the threshold of new possibilities. Physics and chemistry have scarcely started their contributions to the happiness and comfort of human living. Economics and political science are only now beginning to tell us in more confident tones how to make this world a home to live in instead of a place to fight and freeze and starve in.

All these matters await the future peace. Nevertheless they constitute the stern realities of the present, for as Vice-President Wallace has said: "From the practical standpoint of putting first things first, at a time when there are not enough hours in a day and every minute counts, planning for the future peace must of necessity be a part of our all-out war program."

SCIENTIFIC BOOKS

TRENDS IN PHYSICS TEACHING. SOME RECENT TEXTS

THE art of teaching physics has developed almost in its entirety without benefit of the specialist in educational methods. For explanation, one need look no further than an outline of the subject itself. Hard work on the subject-matter is necessary on the part of almost any one before he can lay claim even to an elementary knowledge of physical principles. Many difficulties, not the first being those of mathematics, confront the student who desires a sufficiently good command of the subject to be able to understand its applications in engineering, chemistry, medicine or geology, to mention but a few fields in which special applications of physics abound. The result of this has been the development on the part of physics teachers of attitudes and methods which have made little concession to the tendency in some quarters to soften educational programs to the level of the average student.

This seeming aloofness of the physics teacher has served as a counter irritant, stimulating much of the best work which has been done in the text-book field in recent years, but it has brought with it a loss of influence with departments of education causing a deterioration or even, in many quarters, an abandonment of high-school physics programs and a consequent loss of students to more advanced courses in physics.[1] The war with its vast new instrumentation, whether for combat with the enemy or for civic protection and defense production, has brought into sharp relief the fantastic discrepancy between the need for and the supply of young people who have a laboratory sense of physics.

The situation might, indeed, be much worse had it not been for the formation in 1933 of the American Assocition of Physics Teachers and the establishment of their journal, the *American Physics Teacher,* now known as the *American Journal of Physics.* This journal has from the first been a forum for the expression of all shades of opinion and experience regarding the teaching of physics. In it have originated far-reaching programs for the improvement of the offering to students, for widening and strengthening its appeal and for the testing and evaluation of the results achieved. A nationwide program of testing of physics students under the joint auspices of the American Association of Physics Teachers and the American Council on Education has served also as a stimulus toward revitalizing the physics course at the college level.

Physics first made its way into the curricula of colleges and schools at a time when classical studies were supreme, and the study of physics had to be justified as mental discipline. The first text-books were as formal as grammars and as unvarying in their content. The infusion of qualities which might cause interest in the subject for its own sake by such writers as John Perry and Poynting and Thomson in England, and by our own well-loved W. S. Franklin, was of great service in the early years of this century, but new discoveries in physics and the constantly accelerating pace of new and important applications continually widened the gap between the developing science and the text-books. In the early twenties "modern physics" began to be incorporated into the books, sometimes as a cream puff for dessert, sometimes sprinkled about for seasoning. The most striking result of the many experiences of the compounders of text-books has been the increasing number of topics deemed of such importance as to demand the attention of the beginning student. Drastic experiments with this material have been carried out by some writers. Numerous new aids to teaching, such as the physics museum, have been developed. There has been a multiplication of objectives for which courses and texts have been designed, with a corresponding variation in choice of topics and character of presentation. Especially marked are the differing degrees of emphasis on practical applications and the more fundamental aspects of the science. The result has been a wealth of new books, new editions and new adaptations of older texts.

The commonest professed objective in writing a text-book in physics is the provision of one suitable for a first course, with relatively little mathematics, yet one satisfying requirements for a certain amount of professional training, and which with a little extra effort might also be used in preparation for engineering or for further science study. In this category are the following:

An Introductory Course in College Physics (revised edition). By N. HENRY BLACK. pp. 734+viii. New York: The Macmillan Company. 1941. $3.75.

College Physics. By JOHN A. ELDRIDGE (second edition), pp. 702+xii. New York: John Wiley and Sons, Inc. 1940. $3.75.

College Physics Abridged. By HENRY A. PERKINS. pp. 591+ix, Figs. 450. New York: Prentice-Hall. 1941. $3.50.

Fundamentals of College Physics. By WILLIBALD WENIGER. pp. 694+viii. Figs. 340. New York: American Book Company. 1940. $3.75.

Each of these books uses trigonometry and in varying degree provides the student with instructions for problem solving. Black's book is to a high degree pictorial; besides the many reproductions of line drawings and photographs there are many plates, two of them in color. The illustrations cover a great variety of applications and range in time from such subjects as the experiment with the Magdeburg hemispheres to the electron microscope. Each chapter is provided with a summary, a list of references and a set of problems; topics of special interest or of a more advanced nature are sometimes treated among the problems. The book by Eldridge is also profusely illustrated, but with relatively fewer photographs. There is likewise a résumé at the end of many of the chapters and a large number of questions and problems. The style of the book is personal and stimulating, the point of view is that of the physicist. Perkins' book is an abridgement of the author's "College Physics," which "was written with the purpose of offering such complete explanations of principles and theoretical deductions that the student would understand them without assistance from the instructor." The abridgement was accomplished by elimination of material rather than by condensation. No great concessions are made to popular interest. The topics

[1] See for example, M. H. Trytten, SCIENCE, 94: 387, 1941; also, G. P. Harnwell, *Review of Scientific Instruments,* 12: 571, 1941.

chosen are thoroughly treated and the methods used are such that the book might serve very well as preparation for further courses in physics. Weniger's text is conservative and is no doubt intended primarily as a preparation for engineering. The author does not proceed far with modern physics, but a number of topics in applied physics are given unusual emphasis, as, for example, refrigeration, the elementary theory of the venturi meter and several others. The author takes care to present the theory needed for most of the usual laboratory experiments of the general physics course. Each chapter concludes with a list of suggested laboratory experiments and a goodly assortment of questions and problems.

Physics, the Pioneer Science. By L. W. TAYLOR, with the collaboration in the chapters on modern physics of FORREST GLEN TUCKER. pp. xii + 847 + Appendix xliv. Figs. 551. Boston: Houghton Mifflin Company. 1941. $4.00.

General Physics for Students of Science. By R. B. LINDSAY. pp. 534 + xiv. New York: John Wiley and Sons, Inc. 1940. $3.75.

Foundations of Modern Physics. By THOMAS B. BROWN. pp. 333 + xii. Figs. 155. New York: John Wiley and Sons, Inc. 1940. $3.25.

Laboratory Manual of Physics (second edition). By C. M. KILBY. pp. 146 + vi. New York: D. van Nostrand Company, Inc. 1940. $1.75.

The study of the historical development of physics, particularly the setting in contemporaneous thought of the various stages of evolution of the concepts of physics would seem to be a very special subject, one making the most rigorous demands upon the historian and the philosopher as well as the physicist, yet it is becoming increasingly attractive to many of those seeking to enlarge the resources of physics teaching. The most notable example of the use of historical material in the making of a physics text is without doubt "Physics, the Pioneer Science," by L. W. Taylor. Physical concepts are traced from their origin. Free use has been made of the writings of the original discoverers, and in many cases the argument is presented in its first form. This has resulted in a book which will be of great interest to teachers and many general readers. The text is richly illustrated with reproductions of original prints and diagrams forming a collection well devised to arouse the enthusiasm of any one interested in the history of science. As a text for students its success will depend upon the maintenance by the teacher of interest in the historical approach. It will not be sufficient to "adopt" this book as just another text, but the author has eased the task by providing excellent collections of problems where they are called for. Principal divisions of the subject are introduced by several chapters of preliminary historical material so that by the time the student is working with formulae he should be in command of the whole background of development of concept and law. A very large number of the chapters are sufficiently easy and of such general interest that this book will doubtless find use in general or scientific libraries. A list of references to sources includes 291 items. Excellent indices are provided.

"General Physics" by Lindsay is a "thorough and rigorous introduction to college physics for students who intend to pursue scientific careers." It is intended "to serve as a basic introductory text-book for science students who have had mathematics through elementary calculus, and also to provide an intermediate and more rigorous course for such students as have already taken an elementary, descriptive course in physics." As one would expect of this author, great care is taken in the exposition of fundamental concepts, and there are probably few graduate students of the subject who could not read this book with profit. The author has chosen topics with great skill and has managed to put an astonishing amount of good physics in the 520 pages of text. The student who is prepared to use it may well be congratulated on having such a text made available to him. In colleges where the first course is of the usual sort with little mathematics the present text will provide an ideal second-year course for students majoring in science or mathematics.

The term modern physics in connection with the general physics course has come to mean rather definitely the physics of the electron, and includes such matters as the electric and magnetic deflection of cathode rays and of positive rays, the mass spectrograph and isotopes, x-rays and crystal structure, photoelectric effects and more or less concerning radiation and line spectra. The inclusion of this material has seemed necessary to many writers because of the oft-repeated charge that the student completes his college course in physics without coming into contact with those matters which are the concern of present-day physicists. The inclusion has often been awkwardly made, and the choice of subjects included has seldom pleased any one but the author. Moreover, the limitations of time of most courses are such that the modern physics often receives very sketchy treatment with a holiday for the time being from problems and other systematic exercises. Professor Brown's book, "Foundations of Modern Physics," is intended to serve as the text for the fourth unit of a two-year college course in physics; the criterion for choice of material being that it be that which is "at present greenest with new growth." The book opens with an account of electrons and the determination of electronic charge, e/m, positive rays, the mass spectrograph, isotopes, and closes with a discussion of cosmic rays, cosmic ray shower theory and mesons. Between these two chap-

ters the subject-matter ranges through enough physical optics, radiation theory, including electrical oscillations and waves, black body radiation, spectroscopy, x-rays, radioactivity, nuclear physics, to give the student a very good idea of the principal avenues of recent progress. The treatment is largely non-mathematical and can be followed easily by any one who has had a first course in college physics. An abundance of carefully drawn and well-reproduced figures, discussion of many applications of contemporaneous interest, collections of problems, lists of references, are all features which will appeal to the teacher who would supplement his physics course with a systematic treatment of modern physics or who might well give a three-hour year course in modern physics itself. The student who has the mathematics will doubtless prefer a treatment which will more effectively cross the threshold of this fascinating subject.

No part of the physics course has been under closer scrutiny for many years than the laboratory experiments. Many factors contribute to the present-day history of this subject. Laboratory equipment has become continually and ever more rapidly expensive, mass production has robbed much of it of the refinements and precision of an earlier day. Some of the arguments for physics for physics' sake have dwindled in importance. The mere acquisition of laboratory skill is no longer put forth as a principal objective in college physics courses. Nevertheless, there has never been a time when the importance of laboratory points of view and enough familiarity with instruments to remove the first awkwardness with them have been more clearly recognized. In Kilby's "Laboratory Manual of Physics" will be found a typical list of experiments, together with brief notes concerning their theory and directions for performance. The experiments for the most part require inexpensive apparatus and are suitable for a first course.

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SPECIAL ARTICLES

A QUANTITATIVE ANALYSIS OF SULFONAMIDE BACTERIOSTASIS

WOODS'S[1] observations on the relationship of para aminobenzoic acid to the bacteriostatic action of sulfanilamide and sulfapyridine have been amply confirmed and extended by other investigators.[2,3,4] However, his hypothesis that PAB is an essential metabolite of bacteria, and that the inhibition of bacterial growth by the sulfonamides "is due to competition for an enzyme between the essential metabolite and the inhibitor," has not been adequately supported as yet.

We have been engaged for some time in studies concerning the bacteriostatic potency of various sulfonamide derivatives in relation to (1) the minimal effective concentration of the drugs, (2) the type of media employed, (3) the size of inocula and (4) the amounts of PAB required to prevent bacteriostasis. Some of the results obtained are of interest and may shed new light on the mode of action of these compounds.

The bacteriostatic effects of sulfanilamide, sulfaguanidine, sulfapyridine, sulfathiazole and sulfadiazine were observed in two synthetic, inhibitor-free media, one of which affords sub-optimal growth of the test organism, *E. coli,* whereas the other gives growth comparable to that obtained in nutrient broth. The minimal effective concentration (MEC) of each drug was determined as the lowest molar concentration which prevented visible growth over a period of four days with inocula ranging from 25 to 25,000 cells per cc. These concentrations proved to be the same in both media. With all inocula the absolute amount of PAB required to abolish bacteriostasis was found to be the same for the MEC of each drug, as illustrated in Table I. It will be noted, however, that the $\frac{\text{PAB}}{\text{Drug}}$ ratio is inversely proportional to the MEC, which shows that the bacteriostatic potency of a sulfonamide is directly related to the quantity of the drug required to produce bacteriostasis in the presence of a given amount of PAB. Furthermore, the antagonistic effects of PAB and the sulfonamides are apparently related to their concentrations and are independent of the number of bacteria.

TABLE I

THE RELATIONSHIP BETWEEN THE MINIMAL EFFECTIVE CONCENTRATIONS OF SULFONAMIDES AND PARA AMINOBENZOIC ACID

	Minimal effective drug concentration $M \times 10^{-6}$	Minimal amount PAB required to prevent bacteriostasis $M \times 10^{-7}$	$\frac{\text{PAB}}{\text{Drug}}$ Ratio
Sulfanilamide ...	2500	5	1–5000
Sulfaguanidine ..	500	5	1–1000
Sulfapyridine ...	20	5	1–40
Sulfathiazole	4	5	1–8
Sulfadiazine	4	5	1–8

[1] D. D. Woods, *Brit. Jour. Exp. Path.,* 21: 74, 1940.

[2] E. Strauss, F. C. Lowell and M. Finland, *Jour. Clin. Invest.,* 20: 189, 1941.

[3] W. W. Spink and J. Jermsta, *Proc. Soc. Exp. Biol. and Med.,* 47: 395, 1941.

[4] E. Strauss, J. H. Dingle and M. Finland, *Jour. Immunol.,* 42: 313, 1941.

It was observed that the MEC of all the drugs apparently restrained inocula up to 25,000 cells per cc, but that visible growth invariably occurred with larger inocula, even when much greater amounts of the drugs were added to the cultures. In view of these results it was considered possible that the bacteria might be capable of undergoing a *definite, limited number of cell divisions in the presence of any effective drug concentration, regardless of the inoculum employed.* This hypothesis was examined by inoculating decreasing numbers of *E. coli* into media containing a bacteriostatic concentration of sulfathiazole (5×10^{-4} M), counting the number of viable organisms which developed from each inoculum at 6, 12 and 24 hours, and computing the number of cell divisions from the following formula:

$$S = A \frac{(r^n - 1)}{r - 1}$$

where S = count on developing culture
A = number of cells in inoculum
R = factor of increase (2)
N = number of cell divisions.

The results are recorded in Table II, and show that all the inocula underwent almost exactly the same number of cell divisions within the first 6 hours, with the exception of the largest inoculum, which actually divided fewer times. At 12 hours no further significant change had occurred; at 24 hours the number of organisms had diminished.

TABLE II

THE UNIFORM RESTRICTION OF CELL DIVISION BY SULFATHIAZOLE WITH VARIOUS INOCULA OF E. COLI

Inoculum per cc	Count at 6 hours	Number of divisions	Count at 12 hours	Number of divisions	Count at 24 hours
11,800,000	152,000,000*	3.61	170,000,000	3.80	116,000,000
1,180,000	58,000,000*	5.60	64,000,000	5.70	15,000,000
118,000	13,500,000*	6.85	14,000,000	6.86	5,180,000
11,800	1,190,000	6.65	1,600,000	7.08	267,000
1,180	112,000	6.56	110,000	6.54	5,800
118	11,000	6.54	11,600	6.61	210
11.8	1,180	6.64	1,250	6.72	Sterile

* Visible growth.

The conclusion seems warranted that, in the presence of a bacteriostatic concentration of a sulfonamide, bacteria possess the ability to undergo only a certain limited number of cell divisions, regardless of the size of the inoculum. This readily explains why no apparent bacteriostasis may be observed when large inocula are employed, since even a small number of cell divisions will bring such cultures into the range of visible turbidity (*circa* 10,000,000 cells per cc). For example, Table II shows that cultures inoculated with more than 50,000 *E. coli* per cc attained visible growth, whereas those which received smaller inocula remained clear. The number of cell divisions in each culture, however, was approximately the same. Furthermore, the data also offer a reasonable explanation for the well-known but previously obscure finding that organisms subjected to the action of the sulfonamides grow as rapidly as do controls for a few hours before bacteriostasis becomes manifest.

The reason for this phenomenon is as yet unknown, but it seems possible that the bacterial cell contains a substance necessary for reproduction which is synthesized under normal conditions of growth. In the presence of bacteriostatic concentrations of the sulfonamides the synthesis of this substance is prevented, and the organism is forced to distribute its original supply in diminishing amounts to its progeny. After a certain number of cell divisions the quantity of the substance in the individual organisms becomes insufficient to permit further multiplication. PAB may be concerned with this substance in some way. The observed facts indicate that the antagonism between PAB and the sulfonamides is independent of the number of bacteria, but instead is related principally to critical concentrations of these compounds.

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THE RELATIVE EFFICIENCY OF STRAINS OF RHIZOBIUM TRIFOLII AS INFLUENCED BY SOIL FERTILITY[1]

Arachis hypogaea (peanut) was recently tested in the greenhouse to determine how the response to phosphatic and potassic fertilizers is conditioned by the strains of Rhizobia with which the plants are inoculated. The results suggested that certain cultures were better adapted than others to fix nitrogen in poorly nourished plants, although the cultures differed only slightly in efficiency in well-nourished plants. Since the design of this preliminary experiment did not permit reliability to be placed on the small differences observed, a second, more comprehensive experiment was set up, using *Trifolium pratense* (mammoth red clover) and proper cultures of Rhizobia.

In the second experiment five cultures of *Rhizobium trifolii* were compared on clover grown in Plainfield sand receiving four fertilizer treatments. Cultures 209, 238 and 239 were obtained from the University of Wisconsin, and cultures H and D were isolations from old commercial cultures which had been in the laboratory for two years. The four fertilizer treatments were (1) no fertilizer, (2) P, 100 p.p.m., (3)

[1] Journal Paper No. 9 of the Purdue University Agricultural Experiment Station.

K, 50 p.p.m., and (4) P, 100 p.p.m.-K, 50 p.p.m. Treatments were based on parts per million of elemental phosphorus supplied as $Ca(H_2PO_4)_2 \cdot H_2O$ and elemental potassium supplied as KCl. The soil, when gathered from the field, was deficient in nitrogen, phosphorus and potassium. Commercial seed was surface sterilized, inoculated as desired, and planted, ten seeds to each pot, in steam-sterilized, limed (to pH 6.5) soil. Five-inch pots were used as containers. The experiment was set up in seven randomized blocks. The pots were seeded on April 19, 1941, and harvested on July 15, 1941. Total dry weight and total nitrogen content of the plants were measured.

TABLE I

Culture	Gms. dry wt. produced* in soil fertilized as indicated				Mgs nitrogen produced* in soil fertilized as indicated			
	None	P, 100 p.p.m.	K, 50 p.p.m.	P, 100 p.p.m.-K, 50 p.p.m.	None	P, 100 p.p.m.	K, 50 p.p.m.	P, 100 p.p.m.-K, 50 p.p.m.
209 ...	21.5	19.3	21.5	24.9	515	463	478	604
238 ...	19.3	17.9	22.5	25.5	455	427	500	584
239 ...	18.8	17.5	24.6	27.3	448	414	557	648
H	18.3	16.7	24.0	26.3	461	416	562	636
D	15.5	15.1	19.8	19.4	293	323	419	432
No culture	16.3	15.0	17.1	18.1	307	298	330	324

* Total from the seven replications.

The results of this second experiment (Table I) confirmed the suppositions made from the data of the first experiment. The dry weight and total nitrogen content of plants inoculated with cultures 209 and 239, with and without the addition of potassium, may be taken as an example. When inoculated with culture 209, plants produced a somewhat greater total dry weight and total nitrogen content in unfertilized soil than plants inoculated with culture 239. However, when inoculated with culture 209 dry weight and total nitrogen content of plants do not increase as a result of fertilization with potassium, whereas the increase in dry weight and total nitrogen content of plants inoculated with 239 is quite appreciable. From this it appears highly probable that culture 209 is better adapted to fix nitrogen in potassium deficient clover than culture 239, whereas 239 is better adapted to fix nitrogen in well-nourished plants than is 209. This single example suffices for the purpose of this report.

An analysis of variance of the data on dry matter produced, and subsequent calculation of the mean squares for individual degrees of freedom for interaction between culture and fertilizer treatments, indicates that in the example used above differences are highly significant. In the data on total nitrogen content of the plants, differences in the example cited are highly significant if the data relative to plants inoculated with cultures 209 and 239, with and without potassium, are isolated from the remaining data and analyzed. This procedure is believed justified since there are heterogeneous factors contributing to experimental error in the nitrogen data. For example, several plants receiving no inoculum became contaminated, thus raising the per cent. nitrogen content unduly high. Contamination was less likely in the inoculated groups of plants.

There is no evidence that fertilization with phosphorus changed the relative order of efficiency of the cultures studied.

The occurrence of strains of Rhizobia particularly well adapted to potassium deficient plants is not unexpected in view of what is known of the behavior of Rhizobia. Wilson, Burton and Bond,[2] as well as others, have previously shown that strains of Rhizobia differ in their adaptation to physical and chemical conditions prevailing in given varieties of leguminous plants. For example, two strains of Rhizobia may be of comparable efficiency on one variety of a leguminous plant but differ greatly in their efficiency on another variety of the same species of leguminous plant. However, it seems to us that the demonstration of cultures especially suited to potassium deficient plants has added significance because it suggests the possible development of commercial inoculants especially suited for use with legumes to be grown on particular soil types.

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THE EFFECT OF ARTIFICIAL CHANGES IN THE BRAIN OF MAZE-LEARNING IN THE WHITE RAT

ONE of the authors has published a number of papers[1, 2, 3, 4] on the effect of injections of the pituitary growth hormone (Antuitrin G and Phyone) in tadpoles and in pregnant white rats on the proliferation of brain cells in the young. In general the mammals at birth showed an increase of about 36 per cent. in weight of the cerebral hemispheres, but only about 19 per cent. in body weight. This differential is further emphasized by the fact that the number of cells per volume of cortex increased 86.5 per cent. over that of the controls. Moreover, the increase in volume was

2 P. W. Wilson, J. C. Burton and V. S. Bond, *Jour. Agr. Research*, 55: 619, 1937.

1 S. Zamenhof, "Possibilities of Increasing the Higher Functions of the Cortex," pp. 1–28. Lancaster: Science Press, 1940.

2 *Idem, Growth*, 5: 123–139, 1941.

3 *Idem, Nature*, 148: 3744, 143, 1941.

4 *Idem, Physiol. Zool.*, 1942. (In press).

70.4 per cent., and that in density 9.27 per cent. All these increases are statistically significant. In those animals that reached maturity (3 to 4 months), the total number of cortical neurones was 38–40.6 per cent. greater than that of the controls. The corresponding figure for cell density was 14.8–27.6 per cent.

The question arose as to whether or not this increase in the number of cortical neurones, when produced artificially, would lead to an increase in maze-learning performance. A maze of 12 culs-de-sac of the Warner-Warden design[5, 6] was used. The experimental group consisted of 9 males and 7 females, and were the progeny of mothers that had been injected subcutaneously each day, from the 7th to the 18th or 20th day of pregnancy, with 1 cc of the commercial preparation of the hormone. The control group consisted of 13 males and 9 females, reared under normal conditions. The animals were approximately 2½ months old when tested, and were of the Sherman strain, secured from the Department of Animal Care, College of Physicians and Surgeons, Columbia University. The total number of cortical neurones showed an increase in the experimental group of 38.4 per cent. in the males and 40.6 per cent. in the females. The cell count was made when the rats were from 108 to 124 days old. There was no significant increase in brain weight, body weight or in the thickness of the cortex.

The increase in the number of cortical cells was not effective in speeding up maze performance. The male experimental group required somewhat fewer trials, and made somewhat fewer errors, but the differences were not statistically significant. The females, on the other hand, learned the maze somewhat less readily than the female controls. We must conclude, therefore, that the artificially produced cells have little or no effect on maze behavior. This conclusion should be corroborated by tests on larger groups before it is accepted finally. It is possible, of course, that such an increase in cortical neurones might be effective in a task representing a higher level of intelligence than maze-learning ability.

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[5] C. J. Warden, T. N. Jenkins and L. H. Warner, "Comparative Psychology," Vol. I, p. 242. New York: Ronald Press, 1935.

[6] L. H. Warner and C. J. Warden, *Arch. Psychol.*, 15: 92, 5–27, 1927.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A PETRI DISH HOLDER FOR MECHANICAL STAGES

WORK in these laboratories has shown the need of a holder which will enable a Petri dish to be moved around under the microscope by the smoothly controlled action of the mechanical stage, thus facilitating observation and expediting such operations as delicate dissection or the precise removal of minute material. Obviously such an appliance must fulfil certain requirements. It must permit rapid easy insertion or removal of the dish, whether base down or inverted, whether covered or open, yet must hold the dish firmly and move it smoothly and precisely around on the microscope stage. It must fit the various types of mechanical stages in common use yet permit their full range of mobility so that any part of the dish may be centered, save, perhaps, the extreme periphery of the four-inch size.

To meet these requirements, as various manufactured devices proved inadequate, the writer, three years ago, developed a device which has served satisfactorily through extensive use in these laboratories ever since.

This holder consists essentially of a spring-steel clip which firmly clasps the dish, and is carried by a frame that fits snugly into the slide holder of the mechanical stage (Fig. 1, A). For the clip, the most exacting

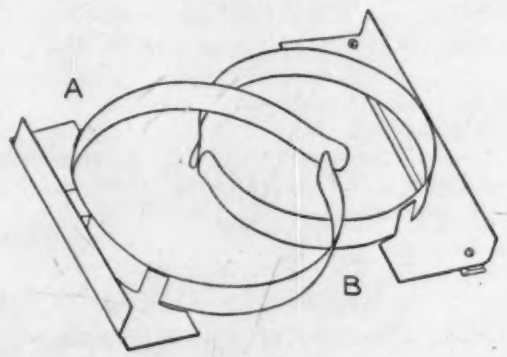

FIG. 1

part of the device, the chromium-plated steel springs sold by photographic supply stores for clipping over reels of 16 mm movie film have proved most satisfactory since they have adequate strength and a width (½ inch) suitable to the height (½ to ⅝ inch) of the common 3- to 4-inch dishes. For smaller Petri or Stender dishes, pieces of clock springs or of bicyclists' trousers clips are also suitable. The frame, of 16- to 20-gauge sheet brass, has a horizontal base about 3 × 1 inch to fit into the slideholder of the stage, with a crescentic aperture of a size to accommodate the dish

and with 3 ears bent up vertically to serve as a three-point attachment for the clip. A piece of film clip (of suitable length and curvature to encircle snugly the inner valve of the Petri dish) is soldered to these three ears with its ends pointing outward and its lower edge just clearing the stage surface (Fig. 1, A).

In use, this holder, its frame firmly gripped in the fingers of the mechanical stage and its clip snugly clasping the periphery of the dish, will move even heavy agar-filled dishes around on the stage without lagging or jerking and with a smoothness and precision that permit work under high dry magnification.

Although this original type of holder in suitable sizes has proved adequate for most of our needs, various modifications have since been developed for special purposes. For the built-in mechanical stages of such microscopes as the Spencer research model the writer uses a holder essentially similar in construction but with its frame screwed to a beveled brass strip that fits into the stage slot in place of the usual slide-holding fingers (*cf.* Fig. 1, B). A somewhat different holder for built-in stages has been devised recently by Dr. Ernest Runyon, of Agnes Scott College, who, without knowing of the writer's appliance, independently has used the same essential principle. In Dr. Runyon's model the clip of clock spring is attached at one end to a small Bakelite block which is screwed to one of the slide-holding fingers of the mechanical stage (*cf.* Fig. 2, A).

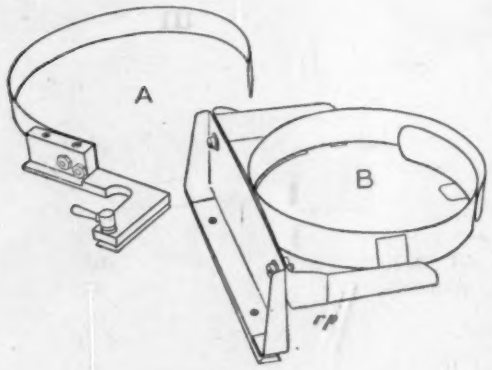

FIG. 2

For holding the uncovered lower valve of a Petri dish upside down so that danger of contamination is minimized during operations on pure cultures growing on nutrient agar the writer uses a holder that supports the valve at a height (about 1 inch) sufficient to permit working with mechanically manipulated needles or pipettes. In this model (Fig. 2, B) the spring clip grips the dish especially tightly and is provided with four lugs projecting slightly from its lower edge so that the dish, although easily inserted, can not fall out. The frame, which extends farther around the dish for greater firmness, is supported by a rigid upright whose beveled base fits the slot of the built-in mechanical stage.

Since these holders have proved helpful in our work, it is hoped that the foregoing description may extend their usefulness to other laboratories.

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THE USE OF DRIED PLASMA FOR THE COAGULASE TEST

THE coagulase test has become an outstanding test for the identification of pathogenic staphylococci.[1,2,3,4,5,6,7] Experiments recently conducted have shown that the test can be satisfactorily carried out, using plasma dried by the cryochem process. Using rabbit plasma (1 per cent. sodium citrate) dried in a modified cryochem apparatus constructed in these laboratories, coagulase tests have been run on a series of coagulase negative and positive staphylococci supplied by Dr. W. N. Plastridge and Dr. J. M. Murphy. Controls were run on each culture, using fresh undried plasma. The technique of Fish[7] was used. Plasma (dried or fresh) was diluted tenfold with physiological saline and inoculated with a large loopful of overnight growths of staphylococci. Perfect agreement between the results with fresh and previously dried plasma has been obtained, clotting having occurred with the strains studied within six hours.

Certain advantages are gained in conducting the coagulase test with dried plasma. Large quantities of plasma can be distributed in convenient amounts, dried and stored for future use. Periodic bleedings at frequent intervals are dispensed with.

The method should facilitate the work of clinical and mobile laboratories.

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1 G. H. Chapman, C. Berens, A. Peters and L. Curcio, *Jour. Bact.*, 28: 343, 1934.
2 R. Cruickshank, *Jour. Path. and Bact.*, 45: 295, 1937.
3 S. T. Cowan, *Jour. Path. and Bact.*, 46: 31, 1938.
4 *Ibid.*, 48: 169, 1939.
5 A. Flaum, *Acta path. mikrobiol. scand.*, Suppl. 35, 1938.
6 R. W. Fairbrother, *Jour. Path. and Bact.*, 50: 83, 1940.
7 A. Fish, *Brit. Jour. Exp. Path.*, 21: 31, 1940.

BOOKS RECEIVED

DRINKER, CECIL K. *Lane Medical Lectures: The Lymphatic System.* Illustrated. Pp. 235. Stanford University Press. $2.25.

Handbook of Civilian Protection. Prepared by the Civilian Defense Council. Illustrated. Pp. xviii + 184. Whittlesey House. $1.25.

Science and Man. Essays. Edited by RUTH NANDA ANSHEN. Pp. viii + 494. Harcourt, Brace. $4.00.

TAYLOR, CLARA MAE. *Food Values in Shares and Weights.* Pp. xi + 92. Macmillan. $1.50.

WILSON, NETTA W. and S. A. WEISMAN. *Modern Medicine: Its Progress and Opportunities.* Pp. vi + 218. George W. Stewart, $2.00.

SCIENCE NEWS

Science Service, Washington, D. C.

THE PROPOSED RAILROAD FROM THE UNITED STATES TO ALASKA

A WARTIME railroad from the United States through Canada to Alaska, instead of the projected military highway, is an engineering possibility. A road of steel connecting industrial America with our northern strategic outposts in Alaska, on the face of it, has many advantages over the road for trucks that has been authorized.

First of all, it could probably be built almost as quickly. It would be able to carry about twenty times as much freight. It would need practically no rubber, prime strategic material of this war, whereas the highway would be only useful with a major expenditure of this precious material for truck tires.

Lying idle in this country are enough good, second-hand rails to build the U.S.–Alaska route. The ties would come right out of the forests along or near the route. Experience of rough-and-ready railroad engineers shows that low-speed freight service can be maintained over track laid with little ballast even over unstable ground such as would be encountered along part of the route. Just as in the case of older railroads, there would be crews of trackmen continually rebuilding the road, but this probably would be little more work than would be needed on a freight highway.

Whether there is a chance that the Government's plans can be revised rapidly enough to get such a strategic railroad underway at this crucial time is not known. There are experienced railroad engineers, many of them in other sorts of engineering, who would be eager to plunge into this new pioneering adventure. Within a matter of days, with red tape hacked away, the two bands of steel could be started northward. There would be a re-enactment of the scenes of America's westward ho! days when steel was laid across the continent. There would be the spirit of the construction gangs that even in these days push mining railroads into untapped country to haul out mineral riches.

Without burdening the Army with the task, an engineering staff could be swiftly organized, experienced trackmen requisitioned from railroads in the country and some of the CCC lads put to work on the job to supplement the labor already in the areas.

With fast action, tractors and other construction machinery could be borrowed from Alaskan and Canadian mines and taken to the line of the railroad over the still frozen ground, ready for a summer of intensive work.

One freight train would carry many times the burden of a whole convoy of trucks. The fuel of the railroad engines would be obtainable from Alaskan and other coal mines whereas the gasoline for trucks on the proposed highway would have to be hauled in tank cars from the south.

In the minds of engineers the sound of sledge on spike is heard already hammering a new road to victory—if railroading has a chance at building this essential link.—WATSON DAVIS.

CONSERVING POWER

THROUGH recent improvements, more power is be obtained from the same fuel and the same amount metal, thus conserving both these needed materials in t war effort, was pointed out by Dr. Lionel S. Marks, em tus professor of mechanical engineering at Harvard U versity, in a Sigma Xi lecture before the Polytechn Institute of Brooklyn. As a representative of the Soci of the Sigma Xi, he will lecture at several other univer ties and colleges in the next two weeks.

Professor Marks spoke only of the immediately a practically available sources of power. He described large power windmill, a more efficient water turbine, n alloys that retain strength at higher temperatures th metals formerly employed—thus permitting higher te peratures on which higher efficiencies of steam and g engines depend, a steam plant that holds the world's e ciency record for this type, a mercury-steam plant th is still more efficient, and the gas turbine which thoug not as efficient as the others has other advantages.

The first large power windmill, Professor Marks stat is now being put into operation. Its capacity is ov 1,300 horsepower. Its "wheel" has but two blades li an airplane propeller. But they are 16 feet in maxim width and sweep out a circle 175 feet in diameter.

A new water turbine, the Kaplan "wheel," is al built like an airplane propeller and maintains its hi efficiency at both light and full loads, contrary to t usual turbine for which the efficiency falls off greatly light loads.

New alloys that maintain strength at 1,000 degre Fahrenheit have made possible a steam-turbine plant th takes superheated steam at this temperature and 2,3 pounds pressure per square inch. This plant develops thermal efficiency of 33.5 per cent. from coal to electri output, a record for a steam plant. With ordinary ste the strength diminishes rapidly as the temperature raised above 700 degrees and since thermal efficiency d pends on the top temperature, turbines using these ste are necessarily less efficient.

A still higher efficiency record of 37.5 per cent. h been made by the mercury-steam turbine. This is high than that of any other engine, including the Diesel e gine. The advantage of this dual system is that satu ated mercury vapor at 1,000 degrees has a pressure only 180 pounds per square inch. It is expanded in turbine to 458 degrees and then used to raise steam 460 pounds pressure which drives another turbine. this way more work is obtained from a pound of fuel an the pressures to handle are much more manageable an permit of lighter construction.

The gas turbine, of which much has at times bee expected, can not at present compete in the high efficienc field. The main difficulties are lack of materials stron enough at the required high temperatures and of a com pact and efficient compressor. However, if the goal high efficiency is abandoned, there is available now a g

turbine of great compactness, simplicity and low cost and possessing other advantages, which is being considered for locomotives. Its efficiency of 16 per cent. puts it about midway between steam and Diesel locomotives.

AIRCRAFT FACTORIES IN BRITAIN

UNDERGROUND stone quarries begun 2,000 years ago in Roman times now are giving sanctuary to British aircraft and war industry factories under constant threat of Nazi air raids. The story of how two of these factories were set up underground is told in a recent issue of the British journal, *The Aeroplane*.

In the first site surveyors, guided by quarrymen who alone knew the planless cities of darkness, made their blueprints for a factory to be artificially heated, ventilated and lighted. One surveyor who strayed from his party was lost for two days. When the quarry was mapped, workmen and electricians swarmed through the cool, dark corridors and the ancient stone, once chipped by hand, now yielded to swift pneumatic drills. Except for adding another million cubic yards of space and strengthening supports, engineers made their factory comply to the quarry. It was unnecessary to widen or straighten the streets and avenues. Walls and roofs were painted yellow to bind the fine dust which could damage precision machinery. Elevators and escalators were built for factory workers and machinery, fluorescent lights installed, ventilators built and canteens and lavatories provided for.

This site is now nearly complete. Six hostels, each quartering 1,000 men or women, are planned, and married quarters for another thousand. The latter will be little bungalows, built in pairs. There will be front and back gardens, even lawns.

The second underground factory is now complete. It is entirely air-conditioned, and the temperature kept from 60 to 65 degrees Fahrenheit. The main canteen, or restaurant, is above ground, but a small room for making tea is underground, and tea is served on trolleys to men and women at work. A feature of this factory is the Control Room, built in an old seepage pit. It is linked to all parts of the factory by telephone, loudspeaker and microphone. Hourly production records are made, and by a glance at the charts the managing director can keep check on any section of the plant. In both underground factories, irreplaceable machines and skilled workmen are safe from the most severe bombing.

THE SHORTAGE OF DRUG AND RELATED PLANT SUPPLIES

WAR has caused an acute shortage in plants used for drugs, insecticides and cooking herbs, yet all that we are missing of the four most important vegetable drugs could be supplied from less than 1,000 intensively cultivated acres, according to a statement made by Professor William J. Bonisteel, of the department of botany of Fordham University, at a meeting in New York City of the Herb Conference.

The pre-war supply of these small but important quantities of pungent and potent plant products came from a large number of sources. The war cut off the supply from more than fifty countries, and reduced our total drug imports from overseas by over 55 per cent.

Amateurs were warned against plunging optimistically into the breach, despite the fact that all the missing drugs and related products can be raised somewhere or other in the Western Hemisphere. Finding congenial soils and climates is a job for skilled botanists rather than for inexperienced beginners.

The four drugs that could be raised in sufficient quantities to supply all U. S. needs on 1,000 acres are digitalis, belladonna, stramonium and henbane. Of digitalis, the standard heart remedy, we need only as much as can be raised on 100 acres; to meet the needs of all Western Hemisphere countries only 200 acres would be enough. A large number of growers are raising digitalis now, and will probably meet the demand adequately.

Belladonna was raised in quantity last year, but the quality was low. For the 1942 season a New York firm is undertaking a program of supervised cultivation by a number of growers. Henbane also seems to be on the way to successful domestic production.

Stramonium is a product of the common jimsonweed, that grows wild in great abundance. Professor Bonisteel suggested that Boy and Girl Scouts might perform a patriotic duty and at the same time raise funds for their troops by collecting it.

Some of the other drug plants that can be satisfactorily cultivated either in this country or elsewhere in the Hemisphere include castor oil beans, ginger, orris root, citronella, henna, ergot, and the numerous pungent seeds of the anise-dill-fennel group.

STEEL

THE toughness of the steel used in our best guns and best armor plate is due to the electric furnace. Stainless steel, so familiar now to the public, would be impossible without the electric furnace. These facts were brought out at the opening session of the Nashville meeting of the Electrochemical Society.

The electric furnace has brought about great changes in the steel industry during the past twenty-five years. Not only can far higher temperatures be attained but the atmosphere above the molten metal can be controlled to a nicety with the electric furnace, whereas in fuel-fired furnaces large quantities of heat are carried away by the thousands of cubic feet of air which are passed through the furnace.

Even in Australia and Brazil, modern methods and the electric furnace are used. Dr. Frank R. Kemmer, of Larchmont, New York, recently returned from Australia, discussed the electric steel industry in that country and described a new steel alloy plant recently erected in Newcastle. W. A. Darrah, of Chicago, discussed the electric steel industry in Brazil.

The use of electrical methods in the production of magnesium, of elemental phosphorus, and in the dewatering of clay were discussed by other speakers.

VITAMIN A CONSUMPTION LIMITED

ALL vitamin A preparations for human use were limited to 5,000 units per person per day by the War Pro-

duction Board in a new order which replaces that issued last February 10. The order does not apply to preparations containing 25,000 units or more per gram. The new order is designed to prevent any shortage due to hoarding or to real lack of fish oils. It increases the amount of vitamin A available for poultry raisers and breeders as an aid to stepped-up egg and meat production. Under the old order, multi-vitamin pills, tablets, capsules and liquids only were limited to the 5,000 units—the amount deemed advisable by medical consultants. The new order applies to all products containing vitamin A, including fortified foods.

Concerning poultry feeds, the old order permitted use only of oils containing 12,000 A units per gram or less. This restriction is now removed. In addition feeds used for breeding are permitted 2,000 A units instead of 1,000.

The purpose of the order was to direct vitamin A consumption into channels where it would do the most good. Domestic poultry must depend largely on artificial provision of vitamin A, since it does not have access to natural foods. Poultry which does not get sufficient vitamin A produces fewer eggs, and chicks have less chance to live. On the other hand, multi-vitamin preparations for human use contained as much as 15,000 A units for daily consumption before the WPB restriction, an amount far in excess of human need. Since the first order applied only to these preparations, and not to fortified foods and candies, it was believed to be unfair and partially ineffective. The purpose of the restriction on human consumption is to prevent a shortage of this vitamin needed by infants and young children for growth and by them and adults as an aid to health and good eyesight.

While no one in Washington is certain, it is believed here that the rumored vitamin A shortage of last fall and winter was artificial, created by commercial vitamin producers to spiral prices. A current survey of vitamin A stocks by the Office of Price Administration, while not conclusive, indicates there will be no vitamin A shortage this year if supply and demand continue as they have in recent months. The most important factor in continued vitamin A production, in the absence of foreign fish oil exports to this country, is the soupfin shark of the Pacific Coast. An additional supply is available in Mexican fish oils. Both sources are uncertain. Continuation of vitamin A taken from the soupfin shark is dependent upon three factors, whether the supply of sharks will hold out, whether prices for shark liver, where the vitamin is stored, will remain high enough to stimulate fishermen, and whether Japanese submarine activity will keep Pacific Coast fishermen ashore. Mexican fish oil supplies are uncertain for similar reasons.

ITEMS

AIR over desert mountains is often as arid as the land beneath it. Studies by Dr. Charles G. Abbot, secretary of the Smithsonian Institution, show that if all the moisture in the air above Montezuma, Chile, were to be brought down in a sudden shower, the rain-gauges there would show a precipitation of less than a hundredth of an inch. Precipitable water in the atmosphere over Washington, D. C., during summer may amount to the equivalent of an inch of rain. The Smithsonian Institution maintains observatories in many parts of the world. Information on amounts of water in the air is obtained as a byproduct of research on total solar radiation reaching the earth. Instruments at the observatories, read several times a day, yield the moisture data because water vapor in the air cuts off certain parts of the solar spectrum. Studies of these radiation data, as they vary before and after storms, indicate that the water that falls as rain or snow is not imported from long distances, but is gathered up in immediately surrounding regions. Also, the indications are that a rain or snow storm is not long in "gathering"; the moisture that is precipitated in a relatively short time, often leaving the air over a given region considerably drier than it was before the storm.

PORTABLE pumps designed primarily for fighting forest and grass fires have been found excellently adapted for combating incendiary bombs, according to *The Journal of Forestry*. They are built to throw a fine spray to a considerable distance, wetting down a maximum area—and this is exactly the treatment required for thermite-magnesium incendiaries. Manufacturers of the most successful forest-fire pumps are working day and night, for they must keep up the usual supply for the protection of our forests, and at the same time take care of a sudden large demand from government and war-industries purchasers.

MUCH-NEEDED vitamin A can be traced in fish tissue by means of ultraviolet light, is stated in the annual report of the Canadian Fisheries Research Board. Because vitamin A is fluorescent it picks up the invisible ultraviolet light and translates the rays into visible light. The problem of discovering which of various tissues is richest in A, and its extraction and concentration, is greatly aided by this technique. Both Canada and the United States are anxious to discover and extract every possible unit of this vitamin which not only aids pilots and navigators to see better at night, but also protects the body against colds and other infections. The United States exports about ten trillion units annually to Great Britain under lend-lease terms.

DR. LELAND R. JOHNSON, in an address at the seventy-eighth annual midwinter meeting of the Chicago Dental Society, reported that boxing gloves, celluloid mouth bits, even golf balls, may be useful in preventing the common dental condition in children known as malocclusion or faulty meeting of the upper and lower teeth. Boxing gloves may be tied on a youngster's hands at night to prevent thumbsucking, a frequent cause of malocclusion, according to Dr. Johnson, while to prevent "mouth breathing," another cause, a small celluloid mouthpiece can be held between the lips while the child is reading or studying. The habit of many children of sleeping with their faces on their hands or fists may cause malformed jaws. It can be prevented, Dr. Johnson said, by preventing children from sleeping on their stomachs. The cure consists of sewing a row of golf balls in the front of the child's pajamas, thus keeping the child sleeping on his back to avoid discomfort.